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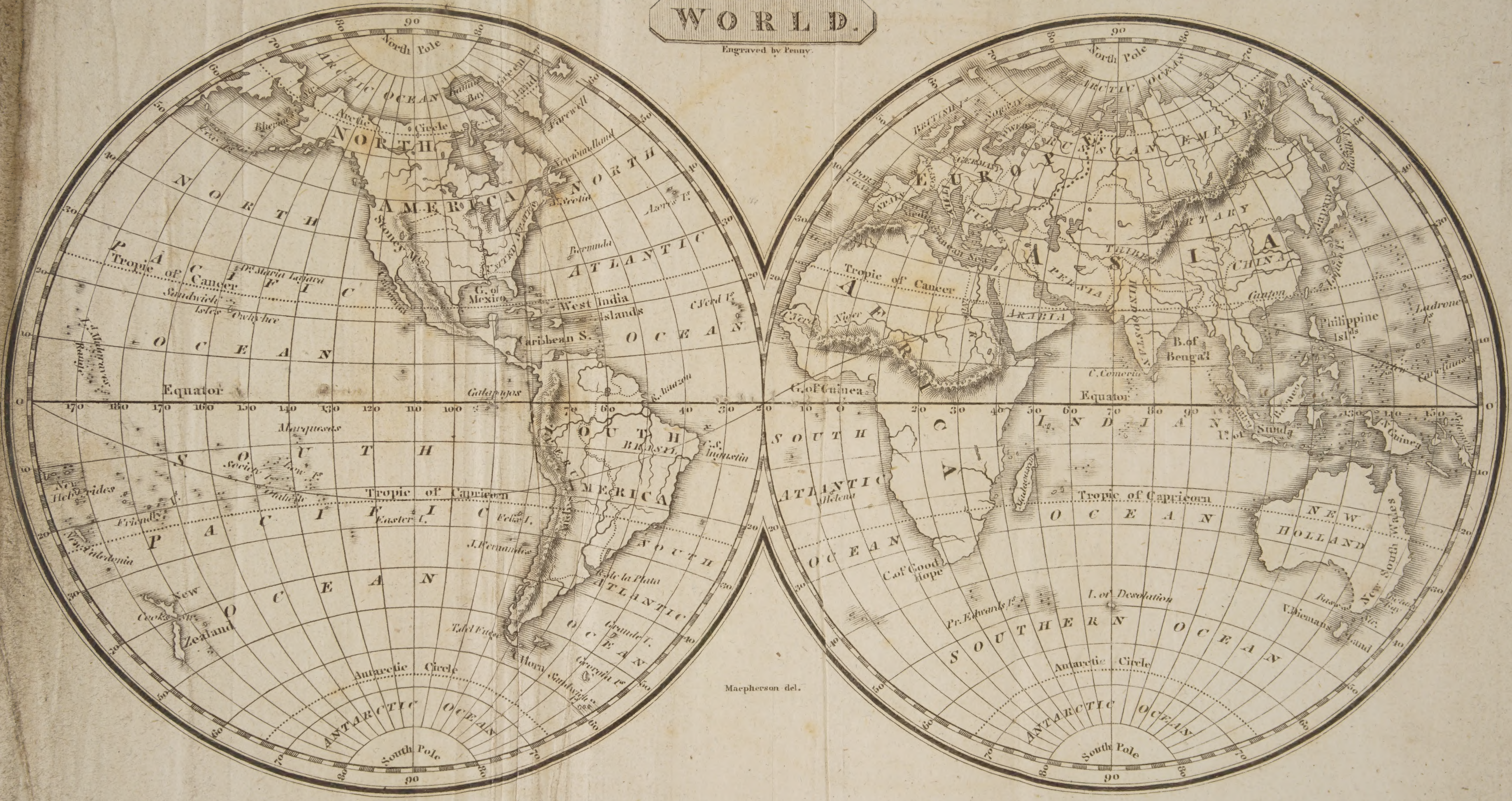

WORLD.

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A

NEW AND EASY GUIDE

TO THE

USE OF THE GLOBES,

AND THE

RUDIMENTS OF GEOGRAPHY.

IN WHICH

The Knowledge of the Heavens and Earth is rendered simple and easy; first, by a concise Account of the Four Quarters of the World, and all the principal Islands; and secondly, by the Solution of a great Variety of useful Problems in Geography, Astronomy, Navigation, Dialling, &c.

ILLUSTRATED WITH PLATES AND MAPS.

To which are subjoined,

TWO APPENDICES:

The I. containing a short Account of the Solar System, of the Comets, and Fixed Stars.

The II. containing Dissertations on the Figure and Magnitude of the Earth;—on the Atmosphere;—on the Tides;—and a short System of Chronology.

By DANIEL FENNING.

THE NINTH EDITION,

CORRECTED AND GREATLY IMPROVED BY THE EDITOR.

LONDON:
PRINTED FOR J. JOHNSON; F. AND C. RIVINGTON; WILKIE AND ROBINSON; G. ROBINSON; SCATCHERD AND LETTERMAN; C. LAW; LONGMAN, HURST, REES, AND ORME; B. CROSBY AND CO.; J. HARRIS; AND SHERWOOD AND CO.

1809.

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TO THE

EIGHTH EDITION.

THIS work was originally dedicated by its author, Mr. FENNING, to all the public tutors and lovers of mathematical learning. By that enlightened, reſpectable, and very uſeful claſs of perſons, it has been liberally patronized through ſeven large and and ſucceſſive impreſſions. In return for this ample and generous ſupport, the proprietors have ſpared no expence in rendering a new edition deſerving of public favour. Some of the maps have been newly engraved, and in the others the late diſcoveries of European travellers and navigators have been inſerted.

The editor to whom the reviſal of the volume has been committed, thinks it right to apprize the reader of the principal improvements which the preſent ſtate of geographical knowledge ſeemed loudly to demand.

In the early part, which is peculiarly devoted to geography, properly ſo called, the diviſions of the earth have been carefully noted and laid down according to the treaty agreed upon by the different European powers, at the peace of 1802. Attention has alſo been paid to aſſign the different iſlands to the reſpective powers to whom, at that time, they were ceded. The ſection on maps will be found highly uſeful to learners, it will enable them to form accurate ideas on a ſubject which is frequently ill underſtood by perſons, who, in other reſpects, have gained ſome knowledge in geography. The tables have been examined and corrected, and that deſcribing the latitudes and longitudes of all the principal places on the earth's ſurface, has been drawn up with the greateſt regard to accuracy; the numbers are carried even to *ſeconds* of a degree, which are rarely to be found in elementary books.

Beſides correcting many errors in that part which relates to the uſe of the globes, dialling, navigation, &c. the editor has annexed to each problem ſeveral examples for the ſake of exerciſing the talents and ingenuity of the learner. By means of theſe, the time and labour of the tutor will be ſaved, and the progreſs of the pupil, in this delightful ſcience, greatly facilitated. New problems have alſo been introduced, as occaſion might require, in order to render the volume more perfect, and thereby to correſpond with the wiſhes of every enlightened inſtructor of youth.

The editor, from long experience in the buſineſs of education, well knows that geography cannot be properly learnt without an almoſt perpetual attention to maps; with this view he has framed from thoſe that accompany this little work, ſeveral hundred queſtions, which, he conceives, are admirably well calculated to bring the learner acquainted with the real and relative ſituation of every country, iſland, conſiderable place, river, &c. in the known world. The utility of this mode of inſtruction is too apparent to ſtand in need of any comment; and the intereſt which young people always take in finding the proper anſwers to ſuch queſtions as are here given, will enſure the moſt ſolid improvement that can even be expected by parents and inſtructors.

LONDON, *Feb.* 1, 1804.

FOR the Ninth Edition the Maps have been all newly drawn and engraved, and a new Plate given to illustrate that part of the Volume which treats of Astronomy and the Solar System. Corresponding additions and improvements have been likewise made in the letter press; so as to render the Volume a very complete Introduction to Geography, Astronomy, and other useful knowledge.

LONDON, Jan. 1809.

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A NEW AND

EASY GUIDE

TO

GEOGRAPHY

AND THE

USE OF THE GLOBES.

DIALOGUE I.

Between Philo, *a Tutor, and* Tyro, *a Pupil, concerning* Geography *in general.*

SECT. I.

TYRO. YOU have already been ſo kind, dear Philo, as to inſtruct me in the principles of common arithmetic, and the rudiments of algebra, and you promiſed to inſtruct me alſo in the uſe of the globes: if therefore it be agreeable to you, I ſhall be very glad to begin immediately.

PHILO. With all my heart; it pleaſes me much to ſee you delight in any thing of this ſort, rather than ſpend your time in idleneſs, which is the parent of miſchief; I am therefore as ready to teach you as you are willing to be taught: but I think it will not be amiſs to give you firſt a general notion of geography, which will not only qualify you the better for this undertaking, but will be a great help to you for the more ready underſtanding whatever you read.

Tyro. I thank you, Sir; for indeed I ſcarcely know what you mean by geogarphy.

Philo. The ſcience of geography includes ſeveral important ſubjects:—it ſhews into what proportions this globe is divided, as with reſpect to land and water;—it deſcribes the various regions of which the land is compoſed; the nature of the government of each; the manners and cuſtoms of the inhabitants of each country, their progreſs in civilization and the arts of life.

Tyro. You ſay the earth is a globe: I ſhould be glad to be informed how it is known that the figure of the earth is really globular.

Philo. The roundneſs of the earth may be proved by a variety of arguments: 1. When we are on board a ſhip at ſea, we may be out of ſight of land, when the land is near enough to be viſible, if it were not hidden from our eye by the convexity of the water. In this caſe, the tops of hills, cliffs, ſteeples, towers, &c. firſt appear to our view, next the buildings, and laſt of all the ſhore; which can proceed from nothing elſe but the roundneſs of the earth, whereby the lower objects are longer concealed from the ſight than thoſe which are higher. 2. The higher the eye is, the farther will the view be extended: it is very common for ſeamen, on the top of the maſt, to diſcover land, or ſhips, at a greater diſtance than thoſe can do who ſtand upon the deck; the object being hidden from the latter by the convexity of the water. 3. When we ſtand upon the ſhore, the higheſt part of a ſhip is viſible at the greateſt diſtance; if a ſhip be going from us out to ſea, we ſhall continue to ſee the maſt, after the hull or body of the ſhip diſappears, and the top of the maſt will be ſeen longeſt. But if the ſurface of the ſea were a flat, every part of an object would be equally viſible; and not the higheſt, but the largeſt part of an object, would be viſible at the greateſt diſtance, ſo that we ſhould be able to ſee the hull of a ſhip farther off than the maſt: but this is contrary to experience; conſequently the earth is round. 4. The convexity of the water may be ſeen in calm weather, and where the fluid is unruffled and ſmooth, provided it be a mile or two in a ſtraight line, for a little boat upon the water may be ſeen by a perſon whoſe eye is a ſmall height above it; but if he ſtoop down and bring his eye near the ſurface, he will find that the boat is covered by the convexity of the water. 5. Several navigators have ſailed quite round the earth; not in an exact circle, the winding of the ſhores preventing them from ſailing on a direct courſe: but by ſailing continually to the weſtward, they have reached the place from whence they at firſt departed. This was performed by Magellan, Cavendiſh, Sir Francis Drake, Lord Anſon, Bougainville, Commodore Byron, the Captains Carteret, Wallis, Cook, and many others. 6. All the appearances of the heavens, both at land and ſea, are the ſame as they would be were the earth a globe, which proves that it really is ſuch. And, laſtly, eclipſes of the moon, which are cauſed by the ſhadow of the earth falling on that planet, demonſtrate that the earth is of a globular figure; for this ſhadow is always circular, whatever ſituation the earth may be in at that time: now a body muſt be globular which always caſts a circular ſhadow. Nor are the uneveneſſes on the earth's ſurface, ariſing from hills and vallies, any material objection to its being conſidered as a round body; becauſe the higheſt mountains bear a leſs proportion to the bulk of the earth, than the little riſings on the coat of an orange bear to that fruit; or a grain of ſand to an artificial globe, of nine inches diameter: and accordingly, we find that the mountains and vallies on the ſurface of the earth cauſe no irregularities in the ſhadow during a lunar eclipſe; the circumference thereof being even and regular, and appearing as if caſt by a body truly globular.

TYRO. Is the common terreſtrial globe a true repreſentation of the earth?

PHILO. It is nearly ſo: the artificial globe is a perfect ſphere, but the earth is what is called a ſpheroid, that is, in the ſhape of an orange, the diameter from *pole* to *pole* being about 37 miles ſhorter than that at the *equator*.

TYRO. I ſhould be glad to know the methods that have been taken to meaſure this globe?

PHILO. The methods made uſe of to meaſure the earth are very plain and eaſy to be underſtood. But it will be neceſſary to obſerve, that every great circle, and conſequently the circumference of the earth, is divided into 360 equal parts, called degrees, and every degree into 60 equal parts, called minutes, &c.

TYRO. This I have already learned in common arithmetic; but why does every circle contain neither more nor leſs than 360 degrees?

PHILO. It was neceſſary to give the preference to ſome number; and probably that of 360 was fixed upon for this reaſon, that it admits of ſeveral convenient diviſions. Thus the half is 180, the quarter 90, and the half quarter 45. Alſo the third of 360 is 120, the third of which again is 40; and few other numbers can boaſt of this advantage, eſpecially as every number in the above diviſions is alſo farther diviſible by five.

Tyro. Then the diviſion of every circle into 360 parts or degrees, was merely for the ſake of convenience?

Philo. It was; and if at two places ſituated north and ſouth of each other, the altitude of the ſun be taken on the ſame day at noon, and the ſun be found to be one degree nearer to the zenith at one place than at the other, thoſe two places are one degree aſunder. Now if the diſtance between theſe two places be meaſured by a chain or otherwiſe, we ſhall know the length of a degree, and conſequently of any part of a degree, in Engliſh meaſure. This has been done by ſeveral geographers, particularly by our countryman, Mr. Richard Norwood, who, in the year 1635, obſerved the difference of latitude, and meaſured the diſtance between London and York. It is now clearly aſcertained, that the length of a degree in latitude 45° is nearly 69.2 Engliſh miles, and this may be conſidered as a mean length; hence $69.2 \times 360 = 24912$ miles, the circumference of the earth. And the circumference being known, the diameter is eaſily found; for every circle is to its diameter as 3.1416 is to 1: therefore we ſay as $3.1416 : 1 :: 24912 : 7930$ miles nearly.

Tyro. The map of the world, prefixed to this work, will give you a much better idea of the world itſelf, than any verbal deſcription. It repreſents the artificial globe taken out of its horizon, ſqueezed flat, or cut through, and the two hemiſpheres placed cloſe to each other.

Tyro. Is it known what proportion the land bears to the water?

PHILO. It is generally ſuppoſed that two thirds of the whole ſurface of the globe are covered with water, conſequently the proportion of land to water is as 1 to 2.

TYRO. Into how many parts is the earth divided?

PHILO. Into four parts, generally called quarters; viz.—1. Europe.—2. Aſia.—3. Africa.—And 4. America.

TYRO. What are the other nominal parts of the earth; or how is it yet farther divided in relation to land and water?

PHILO. It is divided into ten different parts; five belonging to land, viz.—1. A continent.—2. An iſland.—3. A promontory or cape.—4. A peninſula.—And 5. An iſthmus. The other five belong to water, viz.—1. An ocean.—2. A lake.—3. A bay.—4. A gulf.—And 5. A ſtrait. Theſe anſwer to each other, as will plainly appear by the following

DEFINITIONS:

LAND.	WATER.
1. A continent is a large tract, or vaſt extent of main land, not ſeparated by any ocean. Thus Europe, Aſia, Africa, and America, are continents.*	1. An ocean (or ſea) is a large extent or collection of waters, not divided by land; ſuch as the Atlantic or Weſtern Ocean, the Indian Ocean, the Black Sea, &c.
2. An iſland is a tract of land ſurrounded with water; as Great Britain, Ireland, Jamaica, Madagaſcar, &c.	2. A lake is a tract of water ſurrounded by land; as the lake of Geneva, the Dead Sea, the Caſpian Sea, &c.

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* There are in fact only two grand continents, the *old* and the *new*; the former contains Europe, Aſia, and Africa; the latter conſiſts of North and South America.

LAND.	WATER.
3. A promontory, or cape, is a portion of land running far into the ſea; as Cape Verd, Cape of Good Hope, &c.	3. A bay is a portion or part of the ſea running far up the main land; as the Bay of Biſcay, Bay of Bengal, &c.
4. A peninſula is a part of the earth almoſt ſurrounded with water, except a narrow neck of land which joins or unites it to a continent; as Jutland, the Morea in Greece, &c.	4. A gulf is a part of the ocean almoſt ſurrounded with land, except a narrow ſtrait of water, by which it has a communication with the ocean; as the Gulf of Perſia, &c.
5. An iſthmus is a narrow neck of land, by which a peninſula is joined to a continent or main land; as the iſthmus of Panama, which joins North and South America together; the iſthmus of Corinth, &c.	5. A ſtrait is a narrow paſſage of the ſea, which joins one ſea to another; as the ſtrait of Gibraltar, which joins the Mediterranean Sea to the Atlantic Ocean; the ſtrait of Babelmandel, &c. &c.

SECT. II.

OF MAPS.

TYRO. WHAT is a map?

PHILO. A map is a repreſentation of the ſurface of the earth on a plane.

TYRO. What is the difference between a map and the globe?

PHILO. A map differs from the globe as a picture from a ſtatue. If the covering of the globe were taken off and ſpread out on a table, it would be called a map.

TYRO. How many kinds of maps are there?

PHILO. There are two kinds, viz. general and particular.

TYRO. What is a *general* map?

PHILO. A map of the whole world, or ſurface of the globe.

TYRO. What is a *particular* map?

PHILO. A map of ſome particular portion of the world; as of Britain.

TYRO. Will you deſcribe a general map of the world?*

[The pupil, if young, ſhould commit this ſection ſo completely to memory, as to be able to anſwer any queſtion in any order.]

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* Let the reader refer to the map fronting the title.

Philo. A map of the world is divided into an eaſtern and weſtern hemiſphere, and differs in nothing elſe from the ſurface or covering of the globe.

Tyro. Why is it in two hemiſpheres?

Philo. It muſt conſiſt of two parts or hemiſpheres, becauſe two ſides of the globe cannot be ſeen at once.

Tyro. How are theſe hemiſpheres bounded?

Philo By a double line or circular meridian, ſubdivided, to ſhew degrees of latitude.

Tyro. What do each of theſe hemiſpheres contain?

Philo. The right hand or eaſtern hemiſphere contains Europe, Aſia, and Africa; the weſtern or left hand hemiſphere contains North and South America.

Tyro. How are land and water diſtinguiſhed on a map?

Philo. The ſea coaſt, which is the ſeparation of land from water, is repreſented by a dark line and thick ſhading,

Tyro. How are countries and provinces divided?

Philo. Moſt commonly by dotted lines.

Tyro. How are rivers repreſented?

Philo. By black winding lines.

Tyro How are cities repreſented?

Philo. The preciſe ſituation of a city* nerally marked by a little o.

Tyro. How are mountains repreſented

Philo. By figures of little mountains ſketche or drawn.

---

* On ſome maps cities, market towns, boroughs, villages, &c. are diſtinguiſhed from each other by marks appropriated to each.

Tyro. How are foreſts repreſented?

Philo. Foreſts and woods are marked by the figures of little trees.

Tyro. How are roads repreſented?

Philo. When roads are marked on a map, it is by double lines.

Tyro. How are ſand banks and ſhallows in the ocean pointed out?

Philo. By multitudes of ſmall dots.

Tyro. How are maps coloured?

Philo. The land alone is coloured; each different country is covered with a different colour, and all portions of land, iſlands, &c. belonging to a country, muſt be of the ſame colour with that country, wherever they may be ſituated.

Tyro. How is a map commonly conſtructed?

Philo. A map is ſo conſtructed, that its four ſides anſwer to the four cardinal points of the compaſs, north, eaſt, ſouth, and weſt. The top is the north; the bottom the ſouth; the right hand ſide the eaſt, and the left hand ſide the weſt.

Tyro. Are maps ever differently conſtructed?

Philo. When a map is differently conſtructed, there is a magnetic needle, or compaſs delineated on it, which points out the north, and the other points may be known of courſe.

Tyro. What lines are there on a map?

Philo. There are lines which bound it and lines which croſs it.

Tyro. What are the lines by which a map is bounded?

Philo. It is bounded on the north and ſouth by an equatorial line, and on the eaſt and weſt by meridian lines.

Tyro. What is the uſe of the equatorial lines on a map?

Philo. They are divided like the equator* on the globe, into degrees of longitude, which they ſerve to point out.

Tyro. What is the uſe of the meridians?

Philo. They are divided, like the brazen meridian, and point out degrees of latitude.

Tyro. Why are there two of each?

Philo. To prevent the neceſſity of carrying the eye from one ſide of the map to the other.

Tyro. What lines croſs a map?

Philo. There are meridians, or parallels† of longitude, running north and ſouth; and parallels of latitude, running eaſt and weſt: theſe have the ſame uſe as on the globe, viz. to mark longitude and latitude accurately.

Tyro. What do you mean by latitude and longitude?

Philo. The LATITUDE of any place is its diſtance from the equator, either *north* or *ſouth*, numbered in degrees on the brazen meridian. The LONGITUDE is an arch of the equator intercepted between the firſt meridian on the equator, and the meridian of the place.

Tyro. Are there any other lines?

Philo. The Equator, Tropics, and Polar Circles, croſs maps which repreſent the countries that lie under them. The following table exhibits the ſeveral climates north of the equator, preſenting at one view the principal places in thoſe diviſions of the earth.

---

* The equators are generally marked on one ſide with longitude from London, and on the other with longitude from Ferro, which is 18° W. of London.

† The diſtance of theſe parallels from each other, varies in proportion to the ſcale by which a map is projected. It is ſometimes 10°, ſometimes 5°, and ſometimes but 1°.

TABLE I.*

Of the CLIMATES North of the EQUATOR.

Climate	Latitude.		Breadth.		Long. D.		
	D	M	D	M	D	M	
1	8°	25°	8°	25°	12°	30°	This climate contains the Gold Coaſt in Africa, the iſland of Ceylon, Sumatra, Guiana, Terra Firma, &c.
2	16	25	8		13		Ahyſſinia, part of the Mogul's Empire, and farther India, the Iſthmus of Darien, the Windward Iſlands, &c.
3	23	50	7	25	13	30	Nubia, Arabia, Bengal, Canton, Mexico, Jamaica, Cuba, and the Leeward Iſlands.
4	30	25	6	30	14		The Canaries and Coaſt of Barbary, Egypt, Perſia, Gulf of Mexico, Eaſt Florida, &c.
5	36	28	6	8	14	30	Madeira, Gibraltar, Candia, Cyprus, and Rhodes; Jeruſalem, Iſpahan in Perſia, the greater part of China; California, New Mexico, Weſt Florida, Georgia, South Carolina, the Bermudas, and Azores.
6	41	22	4	54	15		Liſbon, Madrid, Sardinia, Naples, the Morea, Natolia, Samarcand in Tartary, Pekin, Japan, North Carolina, Virginia, and Maryland.
7	45	29	4	7	15	30	The North of Spain, South of France, Corſica, Genoa, Rome, Conſtantinople, the Crimea, Tartary, Penſilvania, New York, New England, Long Iſl. & Rhode Iſl.
8	49	01	3	32	16		Paris, Vienna, Preſburg, Little Tartary, Canada, Nova Scotia, Newfoundland.
9	52	00	2	57	16	30	London, Flanders, Prague, Dreſden, Cracow, Breſlaw, Little and Great Tartary, part of Canada, Newfoundland, and New Britain.

10	54	27	2	29	17		Dublin, York, Amſterdam, Hanover, Berlin, Dantzick, Warſaw, part of Ruſſia and Tartary, Labrador, &c.
11	56	37	2	10	17	30	North of Ireland, Edinburgh, Copenhagen, Koningſberg, Moſcow, Siberia, Kamſchatka, New South Wales, Labrador, &c.
12	58	29	1	52	18		Weſtern Iſles of Scotland, South of Sweden and the Baltic, Ruſſia, Siberia, and Hudſon's Bay.
13	59	58	1	29	18	30	The Orkney Iſles, Stockholm, Siberia, &c.
14	61	18	1	20	19		The Shetland Iſles, Bergen, Peterſburgh, Siberia, South of Greenland, &c.
15	62	25	1	7	19	30	Gulf of Bothnia, part of Ruſſia and Siberia, Hudſon's Straits, &c.
16	63	22		57	20		Ruſſia, Siberia, part of Weſt Greenland, &c.
17	64	06		44	20	30	Part of Iceland, Drontheim, Ruſſia, Siberia, and part of Greenland.
18	64	49		43	21		Part of Norway and Finland, Archangel, Siberia, &c.
19	65	21		32	21	30	Part of Iceland, Norway, and Sweden, Ruſſia, Siberia, &c.
20	65	47		22	22		Hecla in Iceland, Norway and Sweden, Ruſſia, Siberia, New Wales, &c.
21	66	06		19	22	30	Norway and part of Lapland, Ruſſia, Siberia, Greenland, &c.
22	66	20		14	23		Norway, Lapland, Ruſſia, Siberia, New North Wales, Greenland, &c.
23	66	28		8	23	30	Norway, Lapland, Ruſſia, Siberia, Greenland, &c.
24	66	31		3	24		Norway, Lapland, Ruſſia, Siberia, Greenland, &c.
25	67	21	1 Month.				Norway, Lapland, Ruſſia, Siberia, Eſquimaux Country, Greenland, &c.
26	69	48	2 Months.				North of Norway, Lapland, Siberia, Greenland, &c.
27	73	37	3 Months.				Nova Zembla, Siberia, Baffin's Bay, Davies's Straits, Greenland, &c.
28	78	30	4 Months.				North of Nova Zembla and Siberia, Greenland.
29	84	05	5 Months.				Spitzbergen or Eaſt Greenland.
30	90		6 Months.				Unknown.

* *This Table will be explained in the Sixth Dialogue, Section Five.*

TABLE II.

SHEWING

The Number of Miles contained in a Degree of Longitude, under each Parallel of Latitude from the Equator.

Degrees of Latitude.	Miles.	100th Parts of a Mile.	Degrees of Latitude.	Miles.	100th Parts of a Mile.	Degrees of Latitude.	Miles.	100th Parts of a Mile.
1	59	96	31	51	43	61	29	04
2	59	94	32	50	88	62	28	17
3	59	92	33	50	32	63	27	24
4	59	86	34	49	74	64	26	30
5	59	77	35	49	15	65	25	36
6	59	67	36	48	54	66	24	41
7	59	56	37	47	92	67	23	45
8	59	40	38	47	28	68	22	48
9	59	20	39	46	62	69	21	51
10	59	08	40	46	00	70	20	52
11	58	89	41	45	28	71	19	54
12	58	68	42	44	95	72	18	55
13	58	46	43	43	88	73	17	54
14	58	22	44	43	16	74	16	53
15	58	00	45	42	43	75	15	52
16	57	60	46	41	68	76	14	51
17	57	30	47	41	00	77	13	50
18	57	04	48	40	15	78	12	48
19	56	73	49	39	36	79	11	45
20	56	38	50	38	57	80	10	42
21	56	00	51	37	73	81	09	38
22	55	63	52	37	00	82	08	35
23	55	23	53	36	18	83	07	32
24	54	81	54	35	26	84	06	28
25	54	38	55	34	41	85	05	23
26	54	00	56	33	55	86	04	18
27	53	44	57	32	67	87	03	14
28	53	00	58	31	70	88	02	09
29	52	48	59	30	90	89	01	05
30	51	96	60	30	00	90	00	00

SECT. III.

A farther Deſcription of the four Quarters of the World; and,

I.——OF EUROPE.

PHILO. EUROPE is the ſmalleſt of the grand diviſions or quarters of the globe, but its inhabitants are more civilized and intelligent than thoſe of the other quarters. In length it is about 3,300 miles from Cape St. Vincent to the Uralian mountains; and its breadth may be about 2,300 miles, from Cape North in Lapland, to Cape Matapan in Greece.

TYRO. What are the principal parts into which Europe is divided?

PHILO. They are nine in number, viz. 1. Scandinavia, (which comprehends Sweden or Swedeland, Denmark, and Norway).—2. Muſcovia, or Ruſſia.—3. France.—4. Germany.—5. Poland.—6. Spain.—7. Portugal.—8. Italy.——And, 9. Turkey.

TYRO. Pray give me ſome ſhort account of theſe with reſpect to their ſituation on the globe, and to each other.

Philo. I will, but it muſt be a ſhort account; juſt enough to give you a general idea of the matter, and qualify you the better for reading and converſation. The map of Europe, which you ſee before you, will be of the greateſt uſe; and the ſituations of places will be much eaſier obtained from this than from any verbal deſcription.

I. *Of* SCANDINAVIA.

Tyro. What do you mean by Scandinavia, and how is it ſituate?

Philo. Scandinavia is a large country, ſituate between 54 and 72 degrees of N. latitude; under which name are comprehended the kingdoms of Sweden, Denmark, and Norway.

1. Sweden.

Tyro. How is Sweden ſituate?

Philo. Sweden is bounded on the N. and W. by Norway, on the E. by Muſcovy, and on the S. by the Sound, and part of the Baltic. Its metropolis or chief town is Stockholm, whoſe diſtance from London is about 886 miles N.E. This city is built on ſeven ſmall iſlands, connected by wooden bridges. The other chief towns are Upſal and Gottenburg.

Tyro. For what is it famous?

Philo. The chief wealth of Sweden ariſes from its mines, which are extremely ſpacious, and afford commodious habitations for a vaſt multitude of families, who ſeem to form a ſubterraneous world. Sweden abounds with rocks, lakes, rivers, and iſlands: of the laſt, thouſands are ſuppoſed to be inhabited.

2. DENMARK.

TYRO. How is Denmark ſituate?

PHILO. Denmark is bounded on the N. by the Sound, on the E. by the Baltic, on the S. by part of Germany, and on the W. by the German Ocean. Its metropolis is Copenhagen, in the iſland of Zealand, whoſe diſtance from London is about 590 miles N. E.

TYRO. For what is Iceland celebrated?

PHILO. Iceland, celebrated for the burning mountain Hecla, is ſubject to Denmark. Hecla is a mile high, and the upper parts of it are covered with everlaſting ſnow. Greenland and the Ferro iſlands belong alſo to the crown of Denmark.

3. NORWAY.

TYRO. How is Norway ſituate?

PHILO. Norway is bounded on the N. W. and S. by part of the main ocean, and on the E. by Sweden. Its metropolis is Bergen, whoſe diſtance from London is about 640 miles N. by E.

TYRO. What kind of a country is Norway?

PHILO. Norway is the moſt mountainous country in the world. Its chief wealth conſiſts in its timber. The inhabitants principally ſubſiſt by fiſhing and hunting.

II. *Of* MUSCOVY *or* RUSSIA.

Tyro. How is Ruſſia ſituate?

Philo. Ruſſia is bounded on the N. by the great Northern Ocean, on the E. by Tartary, on the W. by Sweden and Poland, and on the S. by the Black Sea and Georgia.

Tyro. Is Ruſſia a very large country?

Philo. This country is of immenſe extent; it ſpreads itſelf over all the northerly parts of Europe and Aſia, ſtretching from the Baltic to the Eaſtern ocean. The chief city is Peterſburgh, 1140 miles N. E. of London. The other principal towns are Moſcow, Archangel, Cherſon, Aſtracan, and Tobolſk.

Tyro. Is it like Norway, a mountainous country?

Philo. Ruſſia is perhaps the moſt level country in the world; from Peterſburgh to Pekin in China there is ſcarcely a hill; the ſame is ſaid of the road from Peterſburgh to the north of France. The chief rivers are the Wolga, the Don, and the Nieper. Ruſſia is famous for its timber and flax trade, its iron and copper mines, and its fiſheries.

Tyro. What do you mean by Lapland, and for what is it remarkable?

Philo. The northern parts of Norway, Sweden, and Ruſſia, are called by the general name of Lapland. This country is covered with immenſe foreſts of fir, and the paſtures abound with rein-deer. The Laplanders are hoſpitable, and courageous; they make long excurſions upon the ſnow, by being drawn on ſledges by the deer, who will, upon emergencies, paſs over hill and dale, between two and three hundred miles in a day.

In the northern parts of Lapland, the ſun is abſent for about ſeven weeks; but from ten in the forenoon till between one and two in the afternoon, the twilight is ſufficient for perſons to read without a candle. In the ſummer, the ſun never ſets for ſeven weeks together.

III. *Of* FRANCE.

Tyro. How is France ſituate?

Philo. France is bounded on the N. by the Engliſh Channel, on the E. by Germany, on the S. by part of Spain and the Mediterranean Sea, and on the W. by the Bay of Biſcay. France was formerly divided into provinces, but during the late war it has acquired very extenſive foreign territories, which are now incorporated with that empire, and the whole is divided into 115 departments. Its metropolis is Paris, whoſe diſtance from London is about 210 miles.

Tyro. What are the other chief towns of France?

Philo. The other chief towns are Lyons on the Rhone, Nantes on the Loire, Bourdeaux on the Garonne; Breſt and Toulon are the great ports belonging to France.

Tyro. What are its chief rivers?

Philo. The principal rivers are the Rhone, the Garonne, the Loire, and the Seine; the firſt falls into the Mediterranean, the two next into the Bay of Biſcay, and the Seine into the Engliſh Channel.

The canals in France are very numerous; but that of Languedoc, 180 miles in length, has long been celebrated as the moſt magnificent of European canals.

Of HOLLAND.

Tyro. How is Holland ſituate?

Philo. The United Provinces of Holland, now denominated the Batavian Republic, are bounded by the Northern Ocean, France, and Germany, and they conſiſt of Groningen, Grieſland, Overyſſel, Holland, Utrecht, Guelderland, and Zealand.

Tyro. What are the chief towns, and for what is Amſterdam remarkable?

Philo. The chief towns are Amſterdam, the capital, 180 miles diſtant from London, Leyden, Rotterdam, and Haarlem. Amſterdam is built on piles, and was, before the late war, next to London, the moſt commercial European city.

Tyro. What are the principal rivers?

Philo. The principal rivers are the Rhine, the Meuſe, and the Scheldt. The canals are numerous, and ſerve both in ſummer and winter for the ſame purpoſes as roads in other countries: in the former they are lined with boats; in the latter, all kinds of merchandize are tranſported on the ice by the aſſiſtance of ſkaits.

Of GERMANY, *including* AUSTRIA

TYRO. Is not Germany remarkable for ſome peculiarity in its conſtitution?

PHILO. Yes: it is divided into a great number of independent ſtates. But there are nine grand diviſions called Circles, viz. Auſtria, Bavaria, Swabia, Franconia, Upper and Lower Saxony, Weſtphalia, Lower Rhine, and Upper Rhine.—The emperor is choſen by nine electors, under the title of Emperor of Germany and King of the Romans.*

TYRO. Is not the Emperor ſovereign of Auſtria alſo?

PHILO. Yes, the preſent Emperor is Archduke of Auſtria, and King of Bohemia, in his own right.

TYRO. To whom does the right of electing the Emperor belong?

PHILO. To the Electors of Bohemia, Bavaria, and Saxony; the King of Pruſſia, as Elector of Brandenburg; the Elector of Hanover, the Archbiſhop of Ratiſbon, the Electors of Baden, Wurtemburg, and Heſſe Caſſel.

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* In the year 1806, the ancient conſtitution of the Germanic empire was ſet aſide by the French. The Emperor of Auſtria relinquiſhed the title of Emperor of Germany, and a new political aſſociation was formed of ſeveral conſiderable ſtates, under the title of "the Confederation of the Rhine," at the head of which Bonaparte ſet himſelf. Hoping that, on the arrival of peace, things may return ſomewhat to the former order, we have not altered this and ſome other parts of the volume, which are ſubject to change in each campaign of the war.

Tyro. What are the chief towns and rivers of Germany?

Philo. The towns are, Vienna, the capital, about 760 miles S. E. of London, Dreſden, Hamburgh, Leipſic, Frankfort. The chief rivers are the Danube, the Rhine, the Maine, and the Elbe.

Tyro. What do the Auſtrian dominions comprehend?

Philo. Beſides Auſtria, properly ſo called, it includes Bohemia, Hungary, part of Poland, and the Venetian States. At Vienna the Emperor is conſidered as the lineal ſucceſſor of Auguſtus; in the other provinces he is regarded as the nominal King of Hungary and Bohemia. The chief towns are Venice, Prague, Preſburg, Buda, Cracow, and Trieſte.

Tyro. You ſay part of Poland is included in the Emperor's dominions, is not Poland an independent ſtate?

Philo. It was an independent kingdom till the year 1793, when it was ſeized by Ruſſia, Pruſſia, and Auſtria, who have divided it among themſelves; Ruſſia having by this act of injuſtice acquired about two-thirds of the whole kingdom, and the other third was divided in nearly equal parts between Pruſſia and Auſtria: to the former belongs the formerly flouriſhing but now deſolated Warſaw.

Tyro. By what means was Warſaw deſolated?

Philo. The feeble reſiſtance which the inhabitants made againſt their plunderers induced the ſavage conquerors to deſpoil the city, and 30,000 Poles periſhed either in battle, or by the ſavage mandate of the blood-thirſty Suwarrow, who conducted the Ruſſian army.

Of PRUSSIA.

TYRO. Is Pruſſia a conſiderable European empire?

PHILO. It was formerly very ſmall, but by the acquiſition of Sileſia and part of Poland, it has attained to an important rank among European ſtates. It is divided into Royal Pruſſia, and Ducal Pruſſia; the former lies on the weſt ſide of the Viſtula, and the latter on the eaſt.

TYRO. What are the chief towns and rivers of Pruſſia.

PHILO. The principal towns are Berlin, Koniſberg, Breſlaw, Warſaw, and Dantzwic: and the chief rivers are the Viſtula, the Pregel, and the Memel.

VI. *Of* SPAIN.

TYRO. How is Spain ſituate?

PHILO. Spain, formerly called Iberia or Heſperia, is bounded on the N. by the Pyrenean Mountains and the Bay of Biſcay, on the E. by the Mediterranean, on the S. by the Straits of Gibraltar, and on the W. by Portugal and the Atlantic Ocean.

TYRO. How is it divided?

PHILO. It is divided into 14 provinces, viz. Aſturia, Biſcay, Navarre, Galicia, Leon, Old Caſtile, Arragon, Catalonia, Valencia, New Caſtile, Eſtramadura, Andaluſia, Murcia, and Granada. Its metropolis is Madrid, whoſe diſtance is about

780 miles from London. Its other chief towns are Barcelona, Seville, Corunna, and Cadiz; and the principal rivers are the Ebro, the Tagus, and the Douro.

Tyro. Where is Gibraltar?

Philo. On a promontory in the ſouth of Spain ſtands Gibraltar, a fortreſs which has been in the poſſeſſion of the Engliſh for the laſt century.

Of PORTUGAL.

Tyro. How is Portugal ſituate?

Philo. Portugal is bounded on the N. and E. by Spain, and on the S. and W. by the Atlantic Ocean, and is the moſt weſterly kingdom in Europe. Its metropolis is Liſbon, whoſe diſtance from London is about 980 miles. The other principal town is Oporto, famous for its exports of wine.

VIII. *Of* ITALY.

Tyro. How is Italy ſituate?

Philo. Italy is bounded on the N. by part of Germany, on the N. E. by the Adriatic Sea, or Gulf of Venice, and on the S. and W. by the Mediterranean and part of France.

Tyro. Is the whole of Italy under one government?

Philo. No; it is divided into the Italian Republic, the kingdom of Etruria, the States of the holy Roman church, and the kingdom of Naples.

Tyro. Is not Rome the capital of Italy?

PHILO. Rome is reckoned the capital of Italy, as it is of the Pope's dominions; its diſtance from London is 900 miles. Florence is the capital of Etruria, Milan of the Italian Republic, and Naples of the kingdom of that name. Near Naples is the celebrated burning mountain of Veſuvius, which ſometimes throws its lava to the diſtance of ſeven miles.

IX. *Of* TURKEY *in Europe.*

TYRO. How is Turkey ſituate?

PHILO. Turkey is bounded on the N. by Ruſſia, on the E. by the Black Sea, and part of Turkey in Aſia, on the S. by the Mediterranean, and on the W. by the Gulf of Venice, and part of Germany.

TYRO. How is it divided?

PHILO. It is divided into the *northern* provinces, which are Moldavia, Beſſarabia, Wallachia, Servia, Boſnia, and Dalmatia: the *middle*, viz. Bulgaria, Romania, Macedonia, Albania, and Epirus: and the *ſouthern* part or Greece, which contains Theſſaly, Achaia, and the Morea.

TYRO. What is the metropolis of Turkey, and how is it ſituate?

PHILO. The metropolis of Turkey is Conſtantinople, ſituate between the Black Sea and the Sea of Marmora, whoſe diſtance from London is about 1560 miles E. by S.

The principal rivers are the Danube, the Save, and the Neiſter.

SECT. IV.

Of the EUROPEAN ISLANDS; *and of the United Kingdom of* GREAT BRITAIN *and* IRELAND.

TYRO. WHAT do you mean by Great Britain?

PHILO. It comprehends England, Wales, and Scotland, and is ſuppoſed to contain more than 12 millions of inhabitants.

TYRO. How is it bounded?

PHILO. It is bounded on the N. by the frozen ocean; on the S. by the Engliſh Channel, on the E. by the German Ocean, and on the W. by St. George's Channel.

TYRO. Is not it divided into counties?

PHILO. It is: England contains 40 counties, Wales 12, and Scotland 33 counties. The following is a table of the names of the counties of England, taken as nearly as poſſible in a direction from N. to S. and of the chief town in each county:—

TABLE I.

ENGLAND is divided into the following Counties:

Counties.	*Chief Towns.*	*Counties.*	*Chief Towns.*
Northumberland	Newcaſtle	Buckinghamſhire	Ayleſbury
Durham	Durham	Northamptonſhire	Northampton
Cumberland	Carliſle	Bedfordſhire	Bedford
Weſtmoreland	Appleby	Huntingdonſhire	Huntingdon
Yorkſhire	York	Cambridgeſhire	Cambridge
Lancaſhire	Lancaſter	Norfolk	Norwich
Cheſhire	Cheſter	Suffolk	Bury
Shropſhire	Shrewſbury	Eſſex	Chelmsford
Derbyſhire	Derby	Hertfordſhire	Hertford
Nottinghamſhire	Nottingham	Middleſex	LONDON
Lincolnſhire	Lincoln	Kent	Canterbury
Rutlandſhire	Oakham	Surry	Guildford
Leiceſterſhire	Leiceſter	Suſſex	Chicheſter
Staffordſhire	Stafford	Berkſhire	Abingdon
Warwickſhire	Warwick	Hampſhire	Wincheſter
Worceſterſhire	Worceſter	Wiltſhire	Saliſbury
Herefordſhire	Hereford	Dorſetſhire	Dorcheſter
Monmouthſhire	Monmouth	Somerſetſhire	Wells
Glouceſterſhire	Glouceſter	Devonſhire	Exeter
Oxfordſhire	Oxford	Cornwall	Launceſton

TABLE II.

WALES is divided into the following Counties:

Counties.	*Chief Towns.*	*Counties.*	*Chief Towns.*
Flintſhire	Flint	Radnorſhire	Radnor
Denbighſhire	Denbigh	Brecknockſhire	Brecknock
Montgomeryſhire	Montgomery	Glamorganſhire	Cardiff
Angleſey	Beaumaris	Pembrokeſhire	Pembroke
Caernarvonſhire	Caernarvon	Cardiganſhire	Cardigan
Merionethſhire	Harlech	Carmarthenſhire	Carmarthen

TABLE III.

SCOTLAND is divided into the following Shires:

Shires.	*Chief Towns.*	*Shires.*	*Chief Towns.*
Edinburgh	Edinburgh	Argyle	Inverary
Haddington	Dunbar	Perth	Perth
Merſe	Dunſe	Kincardin	Bervie
Roxburgh	Jedburgh	Aberdeen	Aberdeen
Selkirk	Selkirk	Inverneſs	Inverneſs
Peebles	Peebles	Nairne and Cromartie	Nairne, Cromartie
Lanerk	Glaſgow	Fife	St. Andrew's
Dumfries	Dumfries	Forfar	Montroſe
Wigtown	Wigtown	Bamff	Bamff
Kirkcudbright	Kirkcudbright	Sutherland	Strathy, Darnoch
Air	Air	Clacmannan and Kinroſs	Clacmannan and Kinroſs
Dumbarton	Dumbarton	Roſs	Taine
Bute and Caithneſs	Rothſay	Elgin	Elgin
Renfrew	Renfrew	Orkney	Kirkwall
Stirling	Stirling		
Linlithgow	Linlithgow		

TYRO. What number of inhabitants are there in London?

PHILO. London, the metropolis, contains nearly a million of inhabitants, and is undoubtedly the firſt commercial city in the world.

TYRO. What are the chief rivers in England?

PHILO. The principal rivers in England are the Severn, the Thames, the Humber, the Merſey, the Trent, and the Medway.

TABLE IV.

IRELAND is divided into four Provinces: Leinſter, Ulſter, Connaught, and Munſter. Theſe four Provinces are again ſubdivided into the following Counties:

Counties.	*Chief Towns.*	*Counties.*	*Chief Towns.*
Dublin	Dublin	Antrim	Carrickfergus
Louth	Drogheda	Londonderry	Derry
Wicklow	Wicklow	Tyrone	Omagh
Wexford	Wexford	Fermanagh	Enneſkilling
Longford	Longford	Donegal	Lifford
Eaſt Meath	Trim	Leitrim	Carrick on Shannon
Weſt Meath	Mullingar	Roſcommon	Roſcommon
King's County	Philipſtown	Mayo	Ballinrobe
Queen's County	Maryborough	Sligo	Sligo
Kilkenny	Kilkenny	Galway	Galway
Kildare	Naas and Athy	Clare	Ennis
Carlow	Carlow	Cork	Cork
Down	Downpatrick	Kerry	Tralee
Armagh	Armagh	Limerick	Limerick
Monaghan	Monaghan	Tipperary	Clonmell
Cavan	Cavan	Waterford	Waterford

TYRO. What are the principal towns and rivers in Ireland?

PHILO. The principal towns in Ireland are Dublin, the capital, Cork, Londonderry, and Belfaſt; and the chief rivers are the Shannon, the Blackwater, the Boyne, and the Liffey.

SECT. V.

I. *Of the leſſer European Iſlands, and firſt of ſuch as lie near Great Britain.*

1. THOSE on the north are Shetland and the Orkneys.

2. Thoſe on the eaſt are Holy Iſland, Shepey Iſland, and the Iſle of Thanet.

3. Thoſe on the ſouth are Portland Iſland, the Iſle of Wight, and Portſea Iſland.

4. Thoſe on the weſt are, Lewis Iſland, Skye, Mull, Jura, Ila, Bute and Arran, Man, Angleſey, and Scilly.

II. *Of other European Iſlands, more diſtant from Great Britain.*

1. The Azores, which are nine in number, lie weſt of England, and are ſubject to Portugal.

2. Thoſe of Sweden, the principal of which are Rugen, Oeland, Gothland, Oſel, and Aland.

3. Thoſe of Denmark are Zealand, Funen, Langland, Laland, and Iceland.

4. Thoſe of Norway are Carmen, Hitteren, Sanien, and Weroy.

TYRO. How many iſlands do you reckon in the Mediterranean?

PHILO. There are a great many iſlands, which are ſituate S. of Europe, in or near the Mediterranean Sea; but the following are moſt remarkable:—Yvica, Minorca, Majorca, which are E. of Spain; Corſica, Sardinia, lying S. of Genoa; Malta, Sicily, lying S. W. of Naples; Candia, Rhodes, and Cyprus, S. E. of Natolia.

In the following table I have arranged a variety of particulars, to which you may have occaſion, in the courſe of your reading, to refer. The third column ſhews the population of each country, in millions: the *fourth* ſhews the difference of time between London and any other place: thus when it is twelve o'clock in London it is one at Naples; but at Liſbon it wants 38 minutes of noon.

GENERAL SUMMARY OF EUROPE.

NATIONS.	Chief Cities.	Population in Millions.	Difference of Time from London.		Distance and bearing from London.
			H.	M.	Miles.
Sweden	Stockholm	3	1	10. B.	750 N. E.
Denmark	Copenhagen	3	0	50. B.	500 N. E.
Norway	Bergen		0	24. B.	540 N.
Ruſſia	Peterſburgh	36	2	4. B.	1140 N. E.
France	Paris	32	0	9. B.	200 S. E.
Holland	Amſterdam	3	0	18. B.	180 E.
Germany	Vienna	31	1	5. B.	600 E.
Pruſſia	Berlin	8	0	59 B.	540 E.
Spain	Madrid	11	0	17. A.	800 S.
Portugal	Liſbon	4	0	38. A.	850 S. W.
Italy	Rome	10	0	50. B.	820 S. E.
Turkey	Conſtantinople	8	1	58. B.	1320 S. E.
Great Britain	London	12			
Ireland	Dublin	3	0	24. A.	270 N W.
Naples	Naples	6	1	0. B.	870 S. E.
Hungary	Buda		1	17. B.	780 S. E.
Little Tartary	Precop		2	24. B.	1500 E.
Greece	Athens		1	37. B.	1360 S. E.

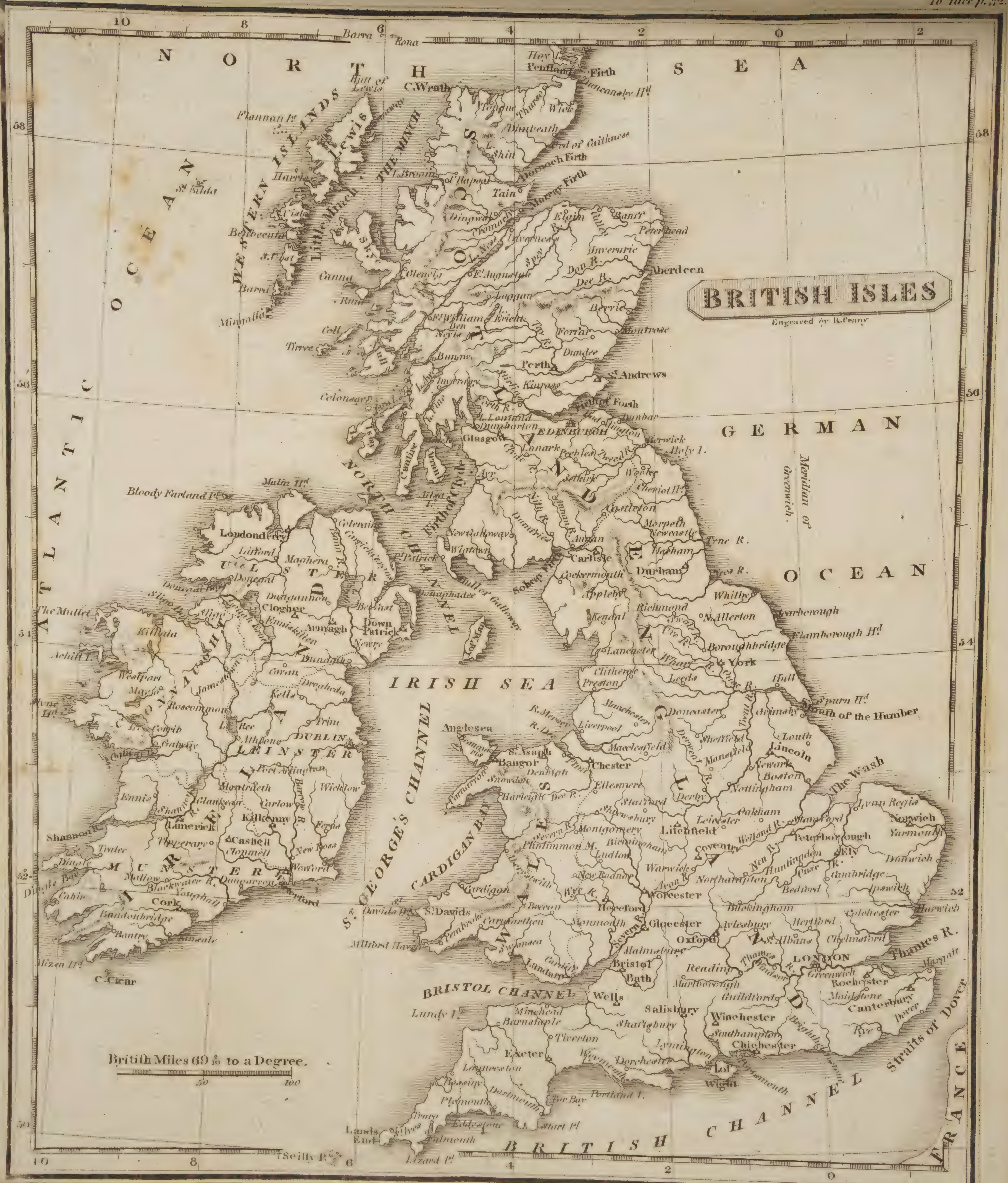
Thus have I, my young friend, given you a brief view of the principal countries of Europe. This fair portion of the globe is chiefly ſituate in the temperate zone, the climate of which has undoubtedly contributed to the vigour of the human frame, and the energy of the mind. The chriſtian religion prevails throughout Europe, except in Turkey, where, however, at leaſt one half of the inhabitants are attached to the Greek church. It is an allowed fact, that wherever the chriſtian faith has penetrated, knowledge, induſtry, and civilization have followed. The two grand diſtinctions are catholics and proteſtants: the *former* predominate in the ſouth, where the paſſions are warm, and the imagination liable to be captivated with ſplendour; the *latter* in the north, where reaſon and judgment prevail. This univerſality of the chriſtian religion has been followed by the great advantage of conſtituting the whole of Europe, as it were, into one republic of letters, ſo that any uſeful diſcovery made in one ſtate paſſes to the reſt with celerity.

The moſt ſtriking and intereſting feature of Europe, is the number and extent of the inland ſeas, juſtly regarded as chief cauſes of the extenſive induſtry and civilization, and conſequent ſuperiority of this, to the other grand diviſions of the globe.

Tyro. I thank you, Sir, for all your information reſpecting Europe, and ſhall be glad to have ſome idea of the other parts of the world.

Philo. This you ſhall have, but it muſt be ſhort; though I am willing you ſhould have as much inſtruction as this ſmall tract will admit of.

To face p. 32.



BRITISH ISLES
Engraved by R. Penny
NORTH SEA
GERMAN OCEAN
Meridian of Greenwich.
ATLANTIC OCEAN
WESTERN ISLANDS
THE MINCH
Little Minch
NORTH CHANNEL
IRISH SEA
S.t GEORGE'S CHANNEL
CARDIGAN BAY
BRISTOL CHANNEL
BRITISH CHANNEL
Straits of Dover
FRANCE
SCOTLAND
ENGLAND
WALES
IRELAND
ULSTER
CONNAUGHT
LEINSTER
MUNSTER
EDINBURGH
DUBLIN
LONDON
Lewis
Skye
Mull
Islay
Arran
I. of Man
Anglesea
I. of Wight
Aberdeen
Perth
Dundee
St Andrews
Glasgow
Dumbarton
Inverness
Carlisle
Durham
Newcastle
York
Hull
Lancaster
Liverpool
Manchester
Chester
Lincoln
Norwich
Cambridge
Oxford
Gloucester
Bristol
Bath
Salisbury
Winchester
Exeter
Plymouth
Canterbury
Londonderry
Belfast
Armagh
Limerick
Kilkenny
Cork
Galway
Wexford
Bloody Farland Pt.
Malin Hd.
Lands End
Lizard Pt.
Scilly Is.
C. Clear
British Miles 69 1/10 to a Degree.
50
100
10
8
6
4
2
0
58
56
54
52
50

DIALOGUE II.

SECT. I.

Of ASIA.

TYRO. IN what part of the globe is Aſia ſituate?

PHILO. Aſia, though called the ſecond, yet in many reſpects is the principal quarter of the globe, lying to the E. of Europe. It extends from the equator to 72 degrees N. latitude.

TYRO. How is it divided?

PHILO. It is divided into ſix principal parts; viz. 1. Tartary. 2. China. 3. India. 4. Perſia. 5. Turkey. And, 6. Arabia.——Theſe parts, as well as the chief ſubdiviſions, are accurately laid down in the map of Aſia, which you ſee before you, and which you ſhould often conſult with attention.

1. *Of Independent* TARTARY.

TYRO. How is Tartary ſituate?

PHILO. Tartary is bounded on the N. by the Frozen Sea, on the E. by the Pacific Ocean, on the S. by China, India, Perſia, and the Caſpian Sea, and on the W. by Ruſſia. This extenſive region is conſidered as the ſeat of the ancient Perſian kingdom.

TYRO. What are the diviſions of Tartary?

PHILO. The chief diviſions of it are, 1. The barren plains in the north. 2. Great Bulcharia, which lies to the ſouth of the Argun mountains. And, 3. The provinces of Sogd, Balk, and Gaur, which are ſouth of the Ak-Tau mountains.—Samarcand is the capital of Tartary, and the principal rivers are the Jihon, and the Sirr or Sihor.

Siberia, now belonging to the Ruſſian empire, and Kamtſchatka, are parts of Tartary.

2. *Of the* CHINESE EMPIRE.

TYRO. How is China ſituate?

PHILO. China is bounded on the N. by part of Tartary, on the E. by the Pacific Ocean, on the S. by part of the Indian Ocean, and on the W. by India without the Ganges. This empire comprehends China Proper, the territory of the Manshews and Moguls on the N. and W. and Thibet.

TYRO. Which is China Proper, and what are the chief cities?

PHILO. It extends from the great wall in the north to the Chineſe ſea in the ſouth, and from the Pacific Ocean to Tibet. The chief cities are Pekin, Nankin, and Canton.

TYRO. What other places are ſubject to China?

Philo. Korea is conſidered as a part of China, and is ſubject to it. So are the iſlands between Formoſa and Japan. The principal rivers are the Kiang and the Whango.

Tyro. Which is the territory of Moguls?

Philo. It is included betweed the great wall and Siberia. To this belongs the iſland of Segalien.

Tyro. How is Tibet ſituate?

Philo. Tibet is included between China and Hindoſtan, the chief town of which is Laſſa.

Tyro. Where is Japan?

Philo. The extenſive empire of Japan, the Jeſſo iſlands, and Macao, lie contiguous to China.

3. *Of* India.

Tyro. How is India ſituate?

Philo. India is bounded on the N. by Tartary, on the E. by China and the Chineſe Sea, on the S. by the Indian Ocean, and on the W. by the ſame ocean and Perſia.

Tyro. How is it divided?

Philo. It is divided into two grand parts, viz. India within, and India without the Ganges. India within the Ganges, or the Great Mogul's empire, contains Delhi (his imperial ſeat), Agra, Cambaia, Bengal, the Decan, Golconda, Viſiapour, Myſore, and the Carnatic.

Tyro. What are the two coaſts called, and what are the chief rivers?

Philo. The weſtern coaſt is called that of Malabar, and the eaſtern that of Coromandel. The two principal rivers are the Ganges and the Indus.

Tyro. Does not a conſiderable part of India belong to Great Britain?

Philo. Britiſh India conſiſts principally of immenſe territories on the banks of the Ganges, of which Calcutta is the capital: of others on the coaſt of Coromandel, of which Madras is the capital—of Ceylon and Bombay.

Tyro. What is India without the Ganges?

Philo. India without the Ganges conſiſts chiefly of Pegu, Tonquin, Laos, Cochin-China, Siam, Cambodia, and Malacca. This is called alſo the Birman Empire. The Birmans are ſeparated from the Hindoos only by a very narrow range of mountains, but the manners, habits, and diſpoſitions of the people, are totally different. The Birmans are iraſcible and impatient; but the Hindoos are celebrated for patience, mildneſs, and humanity.

4. *Of* Persia.

Tyro. How is Perſia ſituate?

Philo. Perſia is bounded on the N. by the Caſpian Sea, on the E. by India, on the S. by the Perſian Gulf, and Indian Ocean, and on the W. by Aſiatic Turkey.

Tyro. How is it divided?

Philo. It is divided into eaſtern and weſtern: beſides the provinces bordering on the Caſpian Sea, which aſſert a kind of independence. Iſpahan, the capital, is about twelve miles in circumference. Teffliz and Gombroon are conſiderable towns.

5. *Of* TURKEY *in* ASIA.

TYRO. How is Turkey in Aſia ſituate?

PHILO. Turkey in Aſia (including Arabia) is bounded on the N. by the Black Sea, on the E. by Perſia, on the S. by part of Africa, and part of the Indian Ocean, on the W. by the Red Sea, the Mediterranean, and the Archipelago.

TYRO. Of what does it conſiſt?

PHILO. It contains Natolia, whoſe chief city is Buria; Syria, or the ancient Canaan, whoſe capital is Aleppo; Diarbecker, whoſe chief city is Bagdat; Turcomania, whoſe capital is Arzerum; and Georgia, whoſe metropolis is Teffliz.

TYRO. By whom is it inhabited?

PHILO. This vaſt country is inhabited by Chriſtians, Mahometans, Jews, &c. but is chiefly under the Ottoman yoke. The principal rivers in Aſiatic Turkey are the Euphrates and the Tigris. The chief mountains are Taurus, Ararat, and Libanus.

6. *Of* ARABIA.

TYRO. How is Arabia divided?

PHILO. Arabia is divided into three parts, Arabia Stony, Arabia Deſert, and Arabia Happy. The *firſt* is a ſmall province north of the Red Sea, between Egypt and Paleſtine; the chief town of which is Suez. The *ſecond* is the middle portion of the country, the inhabited parts of which lie on the borders of the Red Sea; the chief towns of theſe are Mecca and Medina. The *third*, or Arabia Happy, compriſes the ſouth-weſt part of the country.

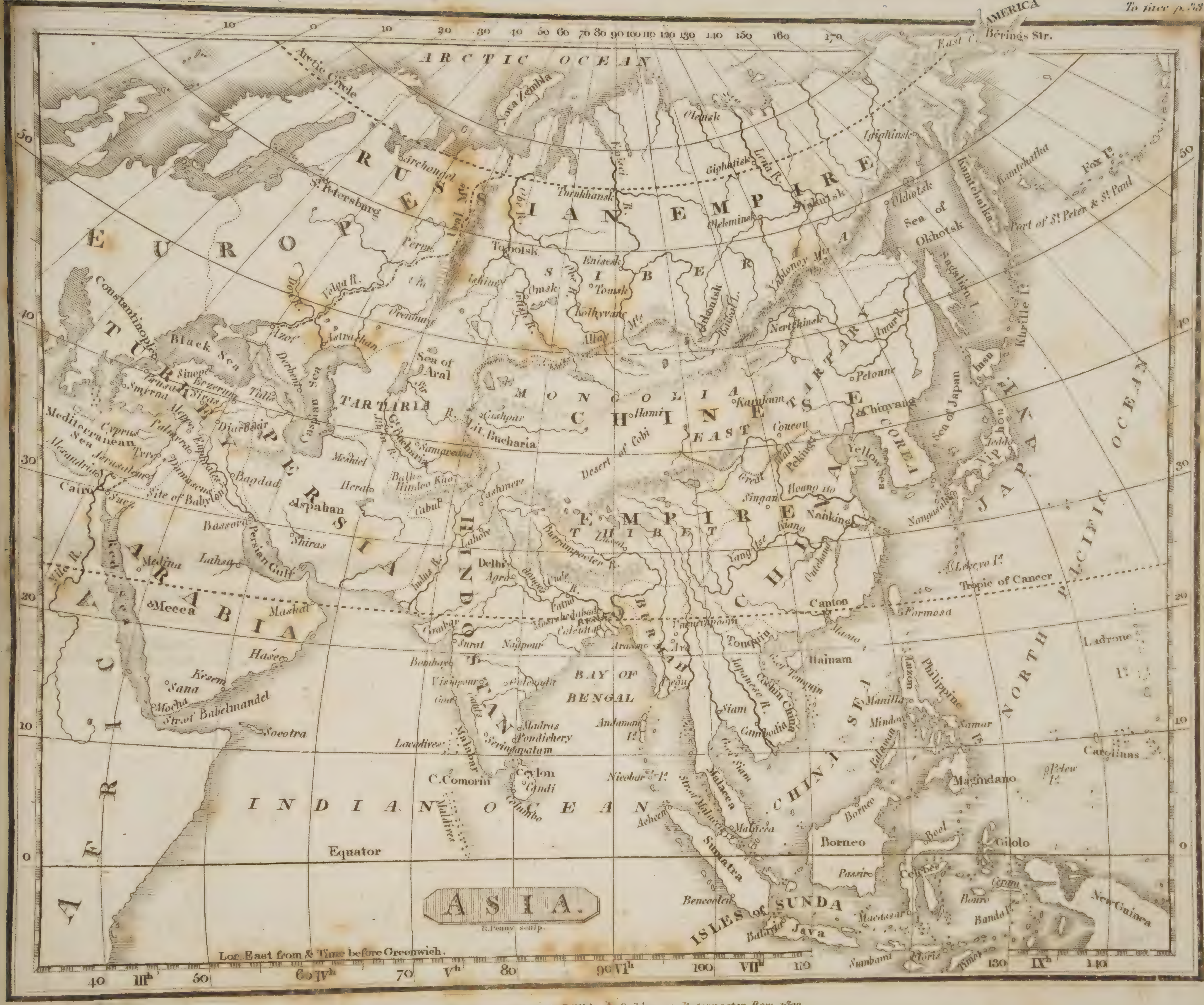
TYRO. Pray give me ſome general account of Aſia.

PHILO. Aſia was anciently the ſeat of the famous Babylonian, Aſſyrian, and Perſian empires; the ſoil of a great part of this diviſion of the globe is extremely fertile; there are in other parts all the varieties from that to the moſt barren, and it is as variouſly cultivated. The people have unequal degrees of induſtry; and it has been remarked, that their activity diminiſhes as their ſituation approaches the equator. It is generally agreed, that the population of the earth began from Turkey, and that country appears admirably ſituated for the purpoſe. In Aſia Jeſus Chriſt was born, and ſpent an active life in endeavouring to reform and ſave the human race.

TYRO. In what ſtate are the ſciences, arts, religion, and languages of Aſia?

PHILO. The natural abilities of the Aſiatics are in general good, but by no means well improved; conſequently literature and the ſciences are in a much lower ſtate than in Europe. It ſhould, however, be obſerved, that ſome parts of Aſia were anciently diſtinguiſhed by their ſuperiority in knowledge; and many uſeful arts had their riſe in Arabia and Phenicia. The religion of ſeveral nations in Aſia is that of Paganiſm, and that of almoſt all the others is Mahometaniſm, there being but a ſmall proportion of Chriſtians in this diviſion of the globe. Jews are found in moſt places here, as well as in the other quarters of the world. The government of moſt Aſiatic countries is abſolute monarchy. The principal

To face p. 33.



Macpherson del.

London, Published by Wilkie & Robinson Paternoster Row 1809.

languages ſpoken in Aſia are, the modern Greek, Turkiſh, Ruſſian, Tartarian, Perſian, Arabic, Chineſe, Japaneſe, and Malayan. The firſt of which is uſed in Ruſſia and Turkey; the laſt in India beyond the Ganges; and the others in their reſpective countries.

SECT. II.

Of the ASIATIC *Iſlands.*

TYRO. HOW many iſlands are here, and how are they ſituate?

PHILO. There are a great number, but they are chiefly reduced to theſe ſix, whoſe ſituation is as follows: 1. Japan Iſlands, E. of China. 2. The Philippine Iſlands, S. W. of Japan. 3. The Moluccas, S. of the Philippine. 4. The Sunda, W. of the Moluccas. 5. The Banda, or Nutmeg Iſlands. And 6. Ceylon, W. of the Sunda, whoſe capital is Candia, or Candy. Beſides theſe, we muſt notice New Holland, which lies ſouth of theſe iſlands, and which is three-fourths as large as Europe; the Pelew iſlands, the Sandwich, and the Society iſlands, are alſo celebrated among modern diſcoveries.

DIALOGUE III.

SECT. I.

Of AFRICA.

TYRO. HOW is Africa ſituate?

PHILO. Africa, the third quarter of the world, is almoſt ſurrounded by the Mediterranean Sea, by the Atlantic, Ethiopian, and Indian Oceans, and is extended from 35 degrees of S. latitude, to about 37 N.

TYRO. How is it divided?

PHILO. It is principally divided into Egypt, Barbary, Biledulgerid, Zaara, called the Deſert, Guinea, Nubia, and Ethiopia, beſides iſlands.

1. *Of* EGYPT.

TYRO. How is Egypt ſituate and divided?

PHILO. Egypt is bounded on the N. by part of the Mediterranean Sea, on the E. by the iſthmus of Suez and the Red Sea, on the S. by Nubia, on the W. by Barbary and the Deſert.

TYRO. How is it divided, and what are the principal cities?

PHILO. It is divided into Upper Egypt, the capital of which is Sayd; Middle and Lower Egypt. Cairo, or, as it is pronounced in the Eaſt, Kahiro, is the metropolis of Africa. The other principal cities are Alexandria, Roſetta, and Damietta.

TYRO. How is Egypt deſcribed?

PHILO. Egypt, though only a narrow vale on both ſides of the Nile, bounded by parallel ridges of mountains or hills, is by far the moſt conſiderable and important part of Africa.

2. *Of* BARBARY.

TYRO. How is Barbary ſituate?

PHILO. Barbary is bounded on the N. by part of the Mediterranean, on the E. by Egypt, on the S. by Biledulgerid, and on the W. by part of the Atlantic Ocean.

TYRO. What does Barbary include?

PHILO. Barbary includes all the northern parts of Africa, and is divided into different ſtates; as Morocco, Fez, Algiers, Tunis, Tripoli, and Barca, the chief towns of which are of the ſame name.

TYRO. By whom is it governed?

PHILO. It is chiefly under the government of the Grand Turk, and of the emperor of Morocco, who is called alſo emperor of Africa, king of Morocco, Fez, &c. and Great Xeriff of Mahomet; conſequently their religion is Mahometiſm. Theſe ſtates are celebrated for their piracies, and for the cruelties with which they treat their captives.

3. BILEDULGERID.

TYRO. How is Biledulgerid ſituate?

PHILO. Biledulgerid is bounded on the N. by Barbary, on the E. by Egypt, on the S. by Zaara, and on the W. by part of the Atlantic Ocean.

4. *Of* ZAARA, *or the* DESERT.

TYRO. How is this Deſert ſituate, and how far does it extend?

PHILO. Zaara is bounded on the N. by Biledulgerid, on the E. by Egypt and Nubia, on the S. by Negro Land, and on the W. by the Atlantic Ocean. It extends from the Atlantic to the Nile, and in magnitude is equal to the half of Europe: it has its iſlands, which are fertile in groves and paſtures.

TYRO. What is ſaid of the weſtern coaſt?

PHILO. On the weſtern coaſt of this continent are innumerable tribes of people, ſuch as the Monſelmines, the Mongearts, &c. &c. About N. Lat. 8° is Sierra Leona, a ſettlement formed by the Engliſh, for the civilization of the interior of Africa.

5. *Of* GUINEA.

TYRO. How is this country ſituate, and for what traffic has it long been known?

PHILO. Guinea lies to the eaſt of Sierra Leona, and contains the Grain Coaſt, the Ivory Coaſt, the Gold Coaſt, and the Slave Coaſt. The whole of this part of Africa is reſorted to by Europeans for ſlaves, with whom they ſupply their Weſt

India Iſlands. This trade, ſo diſgraceful to humanity, and ſo repugnant to every principle of juſtice and moral feeling, has at length been glorioufly aboliſhed as far as concerns this country, and it will, we truſt, hereafter be known to all nations, only as an hiſtorical fact.

Tyro. What other kingdoms are met with to the ſouth and eaſt?

Philo. Purſuing our tract to the ſouth, we meet with the conſiderable kingdoms of Loango, Congo, Angola, and Benguela; and in the ſouth is Caffraria, or the land of Hottentots, which extends quite to the Cape of Good Hope. On the eaſtern ſide of Africa are Natal, Sabia, Sofala, and Mocaranga. The coaſts of Mozambico and Zanquebar are ſucceeded by the deſerts of Ajan and Adel. Beyond theſe is Abyſſinia.

6. *Of* Abyssinia.

Tyro. How is Abyſſinia ſituate?

Philo. It lies W. of the ſtrait of Babelmandel, and is divided into many provinces, of which the principal are Tigri, Gojam, and Dembea. Gondar is the capital.

7. *Of* Nubia.

Tyro. How is Nubia ſituate?

Philo. Nubia is bounded on the N. by Egypt, on the E. and S. by Abyſſinia, and on the W. by part of Zaara. The river Nile runs through it, and the principal towns known to the Europeans are Senaar and Dangola. It is governed by its own independent prince. Their traffic is chiefly to Grand Cairo.

SECT. II.

Of the AFRICAN *Islands, &c.*

TYRO. WHAT are the principal iſlands in Africa?

PHILO. There are many ſmall iſlands, but the moſt remarkable are the following, viz. 1. The iſland of Madagaſcar. 2. Cape Verd iſlands. 3. The Canary. And 4. The Madeira iſlands.

TYRO. For what is Madagaſcar famous?

PHILO. Madagaſcar, which lies E. of Africa, is one of the largeſt iſlands in the world. The face of the country is exceedingly diverſified and agreeable.

TYRO. From what do the Cape Verde iſlands take their name?

PHILO. The Cape Verde iſlands on the weſtern ſide of Africa are about ten in number, and derive their name from the beauty of the verdure. They are ſubject to Portugal. The two largeſt are St. Jago and St. Anthony.

TYRO. Which are the principal of the Canary iſlands?

PHILO. The Canary iſlands, formerly called the *Fortunate* iſlands, are farther north, the principal of which are Teneriffe, famous for its high mountain; and Ferro, from which the degrees of longitude were formerly reckoned by all nations.

Tyro. How are the Madeira iſlands ſituate, and for what are they celebrated?

Philo. The Madeira iſlands are ſtill farther north, and celebrated for their wine.

Tyro. Are there no other iſlands?

Philo. There are many of leſs note, of which the principal are: Socotora, famous for its aloes; it lies near the ſtrait of Babelmandel, and is ſubject to the Arabians. The Comoro Iſlands, N. W. of Madagaſcar; Bourbon and Mauritius, to the eaſt of that iſland. St. Helena, in the Atlantic, famous as a place of refreſhment for ſhips trading to the Eaſt Indies. Aſcenſion Iſland is conſiderably to the N. W. of St. Helena. St. Matthew is N. E. of Aſcenſion, and St. Thomas is farther in the ſame direction, lying in the Gulf of Guinea.

Tyro. Is there any thing remarkable in the inland parts of Africa?

Philo. In Africa there are no inland ſeas, and only one lake of any great extent, viz. that of Maravi.

The principal rivers are the Nile, the Niger, the Senegal, and Sierra Leona.

The grand mountains are the Atlas, and the Mountains of the Moon.

Tyro. Is not Africa very barren?

Philo. The ſurface of Africa is in a great meaſure compoſed of barren moveable ſands; but near the banks of rivers, it is very fertile, and may, by the efforts of well directed induſtry, be made to produce every thing neceſſary for the comfortable ſupport of life. In the northern parts there are many Arabs, deſcended from thoſe who in the ſeventh century made great and extenſive conqueſts in Africa.

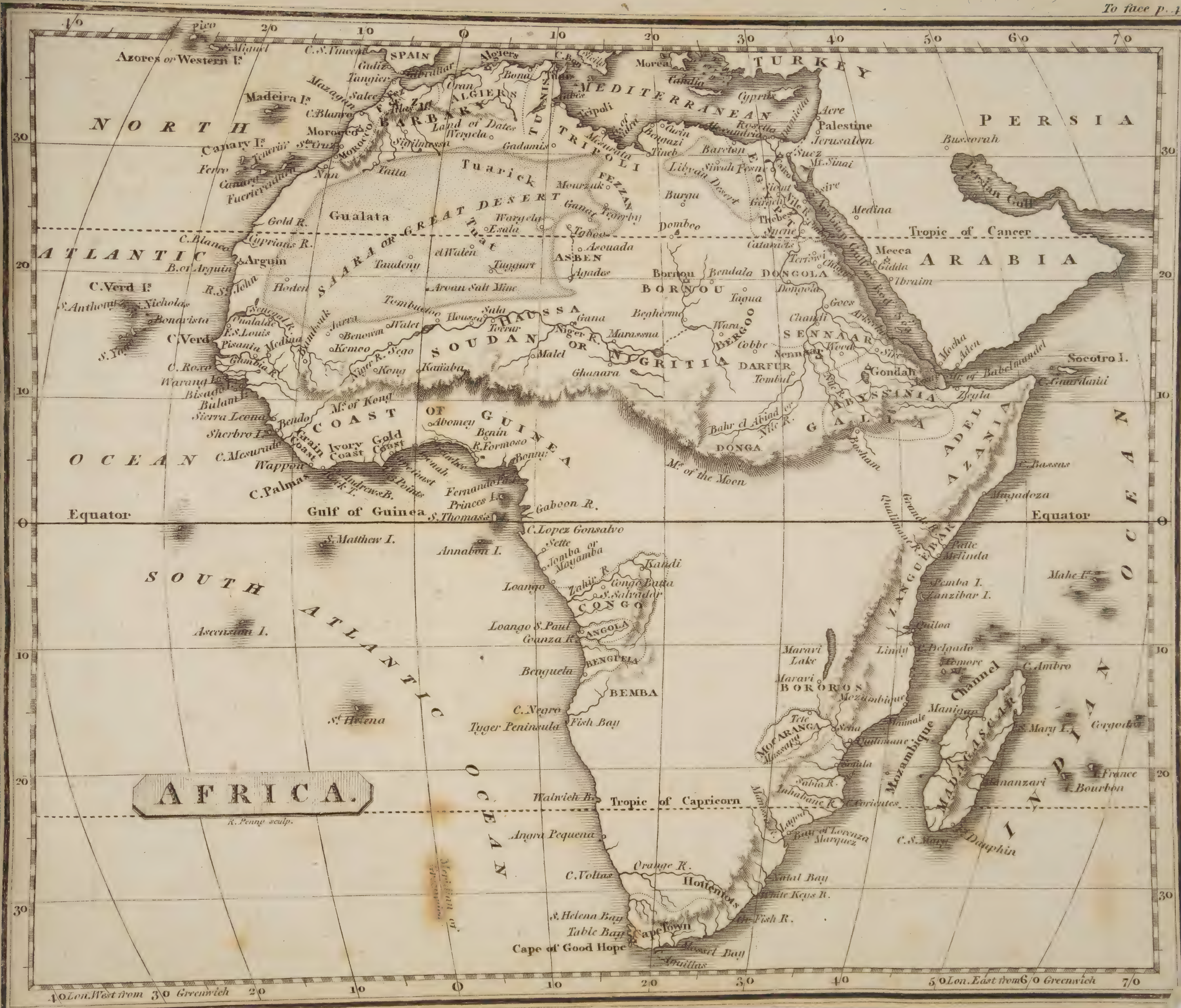
Tyro. What is the trade carried on in Africa?

Philo. There are ſeveral forts on the coaſts of Africa, at which the Europeans carry on trade. The coaſt of Guinea is notorious for the ſlave trade, which ſtimulates the princes of the adjacent inland nations to wage the moſt ſavage and almoſt perpetual warfare with each other; the unfortunate priſoners of either ſide, being the objects of that diſgraceful traffic, for whom formerly Europeans, and particularly merchants of our own country, bartered the moſt trifling manufactures. The ſlaves thus obtained, or ſometimes ſtolen, are carried to the Weſt Indies, in the holds of ſhips, where they endure the moſt exquiſite tortures ariſing from cloſe ſtowage, from exceſſive heat, and thirſt. The ſouthern inhabitants of Africa, or the Caffres, are ſaid to be honeſt in their dealings, and hoſpitable to ſtrangers.

Tyro. What do you ſay of the arts, the government and languages of Africa?

Philo. None of the liberal arts and ſciences are to be found in modern Africa; though Egypt, Ethiopia, and part of Barbary, were anciently famous for the ſkill and refinement of their inhabitants; the two former places had their preſent names, and the latter was called Carthage.—In moſt parts of Africa the government is monarchy. The chief languages are Coptic, Modern Greek, and Arabic.

To face p. 46.



AFRICA.

R. Penny sculp.

DIALOGUE IV.

SECT. I.

Of AMERICA.

TYRO. HOW is America ſituate?

PHILO. America, called the 4th or laſt grand diviſion of the world, is ſituate weſtward on the globe.

TYRO. How is it divided?

PHILO. It is divided into two principal parts; one called North, and the other South America. And accordingly I have drawn two maps, one of the former, and the other of the latter; which will give you ſome general ideas of this extenſive quarter of the globe.

I.—*Of* NORTH AMERICA.

TYRO. Of what principal parts does North America conſiſt?

PHILO. North America, which is ſeparated from South, by the iſthmus of Darien or Panama, includes the poſſeſſions of the Engliſh in the north; the United States in the middle; and the Spaniſh poſſeſſions in the ſouthern part.

Tyro. Are the Britiſh poſſeſſions of conſiderable extent?

Philo. They include Upper and Lower Canada, Nova Scotia, New Brunſwic, the iſland of Cape Breton, and Newfoundland.

Tyro. How are the United States ſituate?

Philo. They lie to the ſouth of the Britiſh dominions, and are divided into northern, middle, and ſouthern. The northern ſtates are Vermont, New Hampſhire, Maſſachuſets, Connecticut, and Rhode iſland. The middle are New York, New Jerſey, Pennſylvania, Delaware, and the territory on the north weſt of the Ohio. The ſouthern ſtates are Maryland, Virginia, Kentucky, North Carolina, Georgia, and the country ſouth of Kentucky.

Tyro. Which are the chief cities?

Philo. The chief cities are Waſhington, the capital; Philadelphia, New York, and Boſton.

Tyro. Of what do the Spaniſh poſſeſſions conſiſt?

Philo. Of Louiſiana, Eaſt and Weſt Florida, New Mexico, and Old Mexico, called alſo New Spain. Beſides theſe, very conſiderable tracts of country are ſtill inhabited by the native tribes, who are independent of every foreign power. Theſe are Greenland, Labrador, the regions about Hudſon's Bay, and thoſe nations on the weſtern coaſt lately diſcovered by Sir A. Mackenzie.

Tyro. Are there no rivers nor mountains in onrth America?

Philo. Yes; the rivers in this continent are a grand and prominent feature of it, of which the principal are the Miſſiſſippi, the Ohio, and the St. Lawrence. The moſt celebrated range of mountains is the Apalachian, which runs through the territory of the United States.

Tyro. What is North America chiefly celebrated for?

Philo. For its lakes, which are unqueſtionably the grandeſt in the world, and might with propriety be denominated inland ſeas: the principal of theſe are lakes Superior, Michigan, Huron, Winnipeg, and the Slave Lake.

Of SOUTH AMERICA.

Tyro. Of what does South America conſiſt?

Philo. It is, as you ſee in the map, an immenſely large continent, and is uſually divided into the following parts: Terra Firma, Guiana, Amazonia, Braſil, Paraguay, Patagonia, Chili, and Peru.

Tyro. I ſee Terra Firma is connected with the iſthmus of Darien.

Philo. It is; and by examining the map, you will eaſily obſerve how the other parts are ſituate. South America has no inland ſea, but the rivers Amazons and La Plata are celebrated as the largeſt in the world. The mountains, particularly the Andes, which follow a tract of nearly 5000 miles, are the loftieſt on the whole face of the globe.

Tyro. To whom do the reſpective parts of South America belong?

Philo. Terra Firma, Peru, Chili, and Paraguay, belong to the crown of Spain; Brazil, which is nearly as large as all theſe together, belongs to the Portugueſe; Guiana belongs partly to the Dutch, and partly to the French; Amazonia is but little known to Europeans, and Patagonia is inhabited by ſavage Indians, whoſe gigantic ſtature has been long noticed by our navigators.

SECT. II.

Of the AMERICAN *Iſlands, and New Diſcoveries.*

TYRO. WHAT are the principal Iſlands of America?

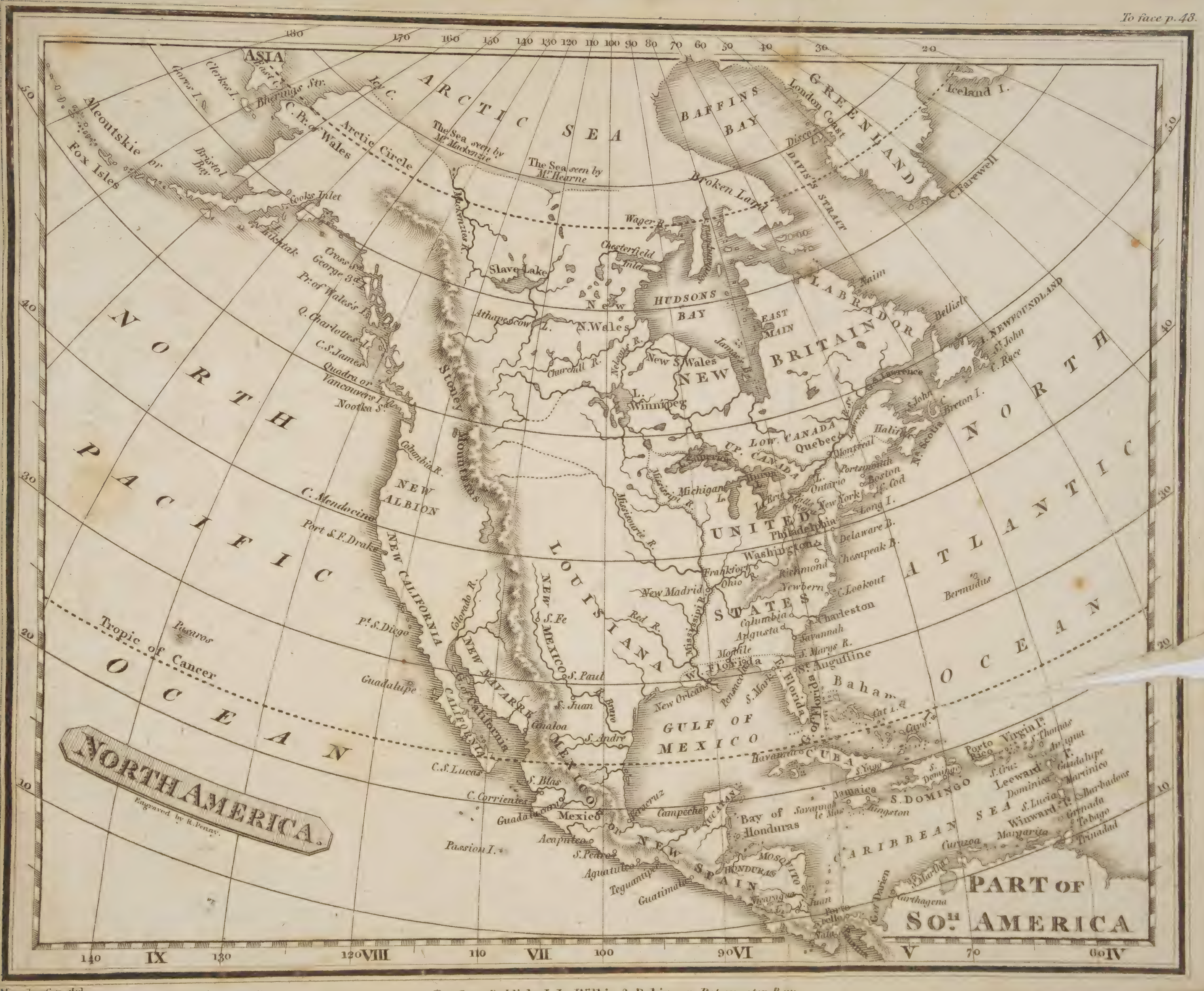
PHILO. In the north are, 1. Newfoundland, famous for its cod fiſhery. 2. Cape Breton, lying between Newfoundland and Nova Scotia. 3. Long Iſland, nearly oppoſite to New York. And 4. The Bermudas, celebrated for cedar wood, and for the perpetual verdure of their trees: they lie in about 32° north latitude. Next to theſe are the

WEST INDIA ISLANDS.

TYRO. How are they ſituate, and to whom do they belong?

PHILO. Theſe extend in a ſort of bow from the coaſt of Eaſt Florida to the river Oroonoko in South America. Cuba, St. Domingo (called alſo Hiſpaniola), Jamaica, and Porto Rico, are the moſt conſiderable. Cuba and Porto Rico, are Spaniſh; Domingo, French, unleſs it be regarded as independent; and Jamaica is the moſt important of the Engliſh Weſt India iſlands.—North of St. Domingo and Cuba are the Bahama, or Lucayos iſlands.

To face p. 48.



Macpherson del.

London. Published by Wilkie & Robinson Paternoster Row.

TYRO. What do you mean by the Caribbees, and by the leeward and windward iſlands?

PHILO. The range of iſlands from Porto Rico to the ſouth are called the Antilles, or Caribbees, which by mariners are divided into the windward and leeward iſlands. The leeward extend from Porto Rico to Dominica, and the windward begin with Martinico, and end with Tobago.

TYRO. To what countries do theſe belong?

PHILO. Thoſe belonging to Britain are, Barbadoes, the moſt eaſterly iſland, Antigua, St. Chriſtopher's, St. Vincent, Dominica, Grenada, &c.

The principal French Caribbee iſlands are Martinique, Guadaloupe, St. Lucie, and Tobago.

The Danes poſſeſs St. Croix and St. Thomas. St. Bartholomew belongs to the Swedes, and Euſtatia to the Dutch.

TYRO. What is the chief produce of theſe iſlands, and how is it cultivated?

PHILO. Sugar is the grand produce of all the Weſt India iſlands. This article is cultivated by ſlaves purchaſed in Africa, and ſold in the Weſt Indies like cattle, to the diſgrace of European merchants.

TYRO. Which are the Falkland and Gallipago iſlands?

PHILO. The Falkland Iſles lie near the Strait of Magellan; and Terra del Fuego, an inhoſpitable and barren region, is ſeparated by the ſame ſtrait from the continent. The Gallipago iſlands are near the equator; and the Pearl iſlands lie in the bay of Panama.

TYRO. Give me ſome general account of America.

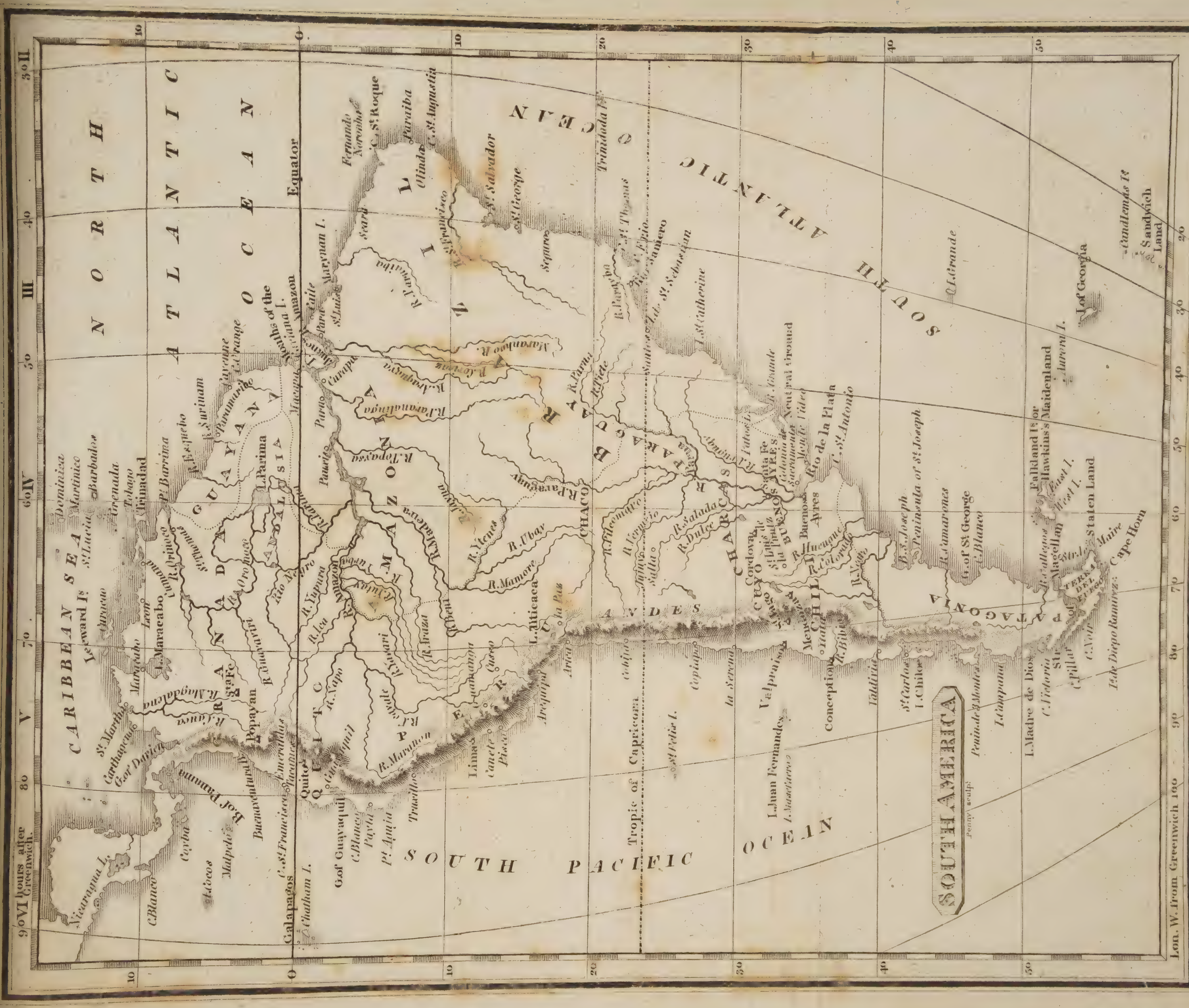
Philo. America was diſcovered in the year 1492, by Chriſtopher Columbus, a Genoeſe. He landed firſt in one of the Bahama iſlands. The vaſt extent of this continent from north to ſouth occaſions almoſt every poſſible variety of ſoil and climate. It is generally fertile, and South America produces prodigious quantities of gold and ſilver, with many valuable jewels and uſeful drugs. In the united States, and the Engliſh and Spaniſh colonies in North America, the inhabitants are chiefly deſcended from Europeans, and, of courſe, in many reſpects, equal to their brethren on the eaſtern continent. In the South American Spaniſh colonies, or, as they are called, *audiences*, is a greater number of original inhabitants, who are generally in the moſt abject ſlavery to the Spaniards. In the independent ſtates, the Indians live in a ſavage ſtate, and are, particularly thoſe of North America, remarkable for the aſtoniſhing fortitude with which they bear the moſt exquiſite tortures conſtantly inflicted on priſoners taken in war.

NEW DISCOVERIES.

Tyro. Can you relate to me the principal modern diſcoveries in geography?

Philo. Of late years ſeveral voyages have been performed round the world, particularly by the celebrated Capt. Cook; and, in the courſe of theſe, ſome new iſlands have been diſcovered, and the coaſts of others more perfectly explored. The principal of thoſe newly diſcovered are, Otaheite, the Society Iſlands, Oheteroa, the

To face p. 57



SOUTH AMERICA

Penny sculp.

London, Published by Wilkie & Robinson, Paternoster Row 1809.

Friendly Iſlands, the New Hebrides, New Caledonia, the Marqueſas, the Pelew Iſlands, and the Sandwich Iſlands; at one one of the latter, called Owhyee, Captain Cook was unfortunately killed, Feb. 14, 1779.

Thoſe more perfectly explored are, New Guinea, New Zealand, and New Holland. The latter is, by much, the largeſt iſland in the world; on the eaſt coaſt of which, called New South Wales, is Botany Bay, the place to which the convicts from Great Britain are now tranſported. Diſtant from London 10,500 miles S. E.

Thus have I given you as complete a view of Geography as I could in ſo narrow a compaſs; and I hope it will be ſufficient to excite your curioſity, and qualify you in time for underſtanding thoſe authors that have treated more largely and particularly on the ſubject.

* * *

THE following Table you will find of great uſe, as well in working problems on the globes, as alſo in your general reading; and the places being arranged in alphabetical order, they will be eaſy of reference. I will give you an inſtance; in the newſpaper you meet with a fact that happened at Modena, you do not recollect where Modena is, look to the Table, and you find every thing to enable you to conſult your map or globe with advantage.

A TABLE

OF THE

LATITUDES AND LONGITUDES,

(In Degrees, Minutes, and Seconds,)

OF THE

PRINCIPAL PLACES ON THE EARTH'S SURFACE.

25-86

Names of Places.	Continent.	Sea or Country	Latitude. 60 – 27			Longitude.		
Abo	Europe	Finland	50°	7′	4″N.	1°	49′	43″E.
Agra	Aſia	India	26	43	0 N	76	44	0 E.
Aleppo	Aſia	Turkey	35	11	25 N.	37	10	0 E.
Alexandria	Africa	Egypt	31	11	28 N.	30	10	22 E.
Algiers	Africa	Algiers	36	49	30 N.	2	12	45 E.
Amiens	Europe	France	49	53	43 N.	2	17	56 E
Amſterdam	Europe	Holland	52	21	56 N.	4	81	30 E.
Amſterdam Iſle	Aſia	Pacific Ocean	21	9	0 S.	174	46	0 W
Antigua	Am.	Caribbee Sea	17	4	30 N.	62	9	0 W
Archangel	Europe	Ruſſia	64	33	36 N.	38	59	15 E.
Athens	Europe	Turkey	38	5	0 N.	23	52	30 E.
Avignon	Europe	France	43	56	58 N.	4	48	10 E.
Babelmandel	Africa	Abyſſinia	12	50	0 N.	43	50	0 E.
Babylon	Aſia	Meſopotamia	33	0	0 N.	42	46	30 E.
Bagdad	Aſia	Meſopotamia	33	19	40 N.	44	24	30 E
Barbadoes	Am.	Atlantic	13	0	0 N.	59	50	0 W
Barcelona	Europe	Spain	41	23	0 N.	2	13	0 E.
Batavia	Aſia	Java	6	12	0 S.	106	56	46 E.
Berlin	Europe	Germany	52	31	30 N.	13	22	0 E
Bermudas	Am.	Atlantic	32	35	0 N.	63	28	0 W
Bojador C.	Africa	Negroland	26	12	30 N	14	27	0 W
Boſton	Am.	New England	42	22	11 N.	70	59	0 W
Botany Bay	Aſia	New Holland	34	0	0 S.	151	21	0 E
Breſlaw	Europe	Sileſia	51	3	0 N.	17	8	45 E
Breſt	Europe	France	48	22	42 N.	4	29	19 W
Cairo	Africa	Egypt	30	3	12 N.	31	18	16 E
Calcutta	Aſia	India	22	34	45 N.	88	29	30 E.
Candia (Iſle)	Europe	Mediter. Sea	35	18	35 N.	25	18	0 E.
Canton	Aſia	China	23	8	9 N.	113	2	30 E.
Cayenne	Amer.	Guiana	4	56	15 N.	52	15	0 W
Ceylon, S.	Aſia	India	5	47	0 N.	81	2	0 E.
Cochin	Aſia	India	9	33	0 N.	75	35	0 E.
Conſtantinople	Europe	Turkey	41	1	27 N.	28	55	0 E.
Cracow	Europe	Poland	49	59	20 N.	19	50	0 E.
Cyprus	Aſia	Syria	34	30	0 N.	33	16	0 E
Dantſwick	Europe	Poland	54	21	9 N.	18	38	0 E.

Names of Places	Conti-nent.	Sea or Country	Latitude.	Longitude.
Dublin	Europe	Ireland	53° 21′ 11″ E.	6° 6′ 30″ W.
Falſe Bay	Africa	Caffres	34 16 0 S.	18 44 0 E.
Farewell, C.	Amer.	Greenland	59 38 0 N.	42 42 0 W.
Ferro Iſle	Africa	Canaries	27 47 20 N.	17 45 50 W.
Fineſterre, C.	Europe	Spain	42 54 0 N.	9 17 10 W.
Florence	Europe	Italy	43 46 30 N.	11 3 30 E.
Francfort	Europe	Germany	49 55 0 N.	8 35 0 E.
Geneva	Europe	Savoy	46 12 0 N.	6 0 0 E.
Genoa	Europe	Italy	44 25 0 N.	8 56 37 E.
St. George, F.	Aſia	India	13 4 54 N.	80 28 45 E.
Gibraltar	Europe	Spain	36 6 30 N.	5 22 0 W.
Good Hope, C.	Africa	Caffres	33 55 42 ~~N.~~	18 23 15 E.
Goree, Iſland	Africa	Atlant. Ocean	14 40 10 N.	17 25 0 W.
Gottenburgh	Europe	Sweden	57 42 0 N.	11 38 45 E.
Greenwich	Europe	England	51 28 40 N.	00 00 00 —
Guadaloupe	Amer.	Caribbee Sea	15 59 30 N.	61 48 15 W.
Guernſey	Europe	Britiſh Chan.	49 30 0 N.	2 47 0 W.
Hague	Europe	Netherlands	52 4 10 N.	4 17 30 E.
Hamburgh	Europe	Netherlands	53 33 3 N.	10 1 11 E.
Hanover	Europe	Germany	52 22 18 N.	9 48 15 E.
Havannah	Amer.	Cuba	23 11 52 N.	82 18 30 W.
St. Helena	Africa	Atlant. Ocean	15 55 0 S.	5 49 0 W
Holyhead	Europe	Wales	53 23 0 N.	4 40 0 W.
Horn, Cape	Amer.	Terra D. F.	55 58 0 S.	68 13 0 W.
Jamaica	Amer.	Atlant. Ocean	18 0 0 N.	76 44 30 W.
Janeiro, R.	Amer.	Braſil	22 54 10 S.	42 43 45 W.
Jeruſalem	Aſia	Paleſtine	31 46 34 N	35 20 0 E.
Iſpahan	Aſia	Perſia	32 25 0 N.	52 50 0 E.
Kiow	Europe	Ukraine	50 27 0 N	30 27 30 E.
Kola	Europe	Lapland	68 52 30 N	33 0 30 E.
Ladrone	Aſia	Pacific Ocean	22 2 0 N.	113 56 0 E.
Land's End	Europe	England	50 4 7 N.	5 41 31 W.
Leghorn	Europe	Italy	43 33 0 N.	10 25 0 E.
Leyden	Europe	Holland	52 8 40 N.	4 28 0 E.
Lima	Amer.	Peru	12 1 15 S.	56 49 30 W.
Liſbon	Europe	Portugal	38 42 25 N.	9 4 40 W.
Liverpool	Europe	England	53 22 0 N.	3 10 0 W.
London	Europe	England	51 31 0 N.	0 5 37 W.
Madeira	Africa	Atlant. Ocean	32 37 40 N.	16 56 0 W.
Madras	Aſia	India	13 4 54 N.	80 28 45 E.
Madrid	Europe	Spain	40 25 18 N.	3 12 0 W.
Malta	Africa	Mediter. Sea	35 53 47 N.	14 28 30 E.
Marſeilles	Europe	France	43 17 43 N.	5 21 43 E.
Mauritius	Africa	Indian Ocean	20 9 45 S.	57 29 15 E.
Mecca	Aſia	Arabia	21 40 0 N.	41 0 0 E.
Mexico	Amer.	Mexico	19 25 50 S.	100 5 45 W.
Milan	Europe	Italy	45 27 57 N.	9 11 45 E.
Modena	Europe	Italy	44 34 0 N.	11 12 30 E.
Montpelier	Europe	France	43 36 29 N.	3 52 25 E.
Montreal	Amer.	Canada	45 50 0 N.	73 11 0 W.

Names of Places	Continent.	Sea or Country	Latitude.	Longitude.
Moſcow	Europe	Ruſſia	55° 45′ 45″ N.	37° 32′ 45″ E.
Munich	Europe	Bavaria	48 9 55 N.	11 30 0 E.
Namur	Europe	Netherlands	50 28 32 N.	4 44 45 E.
Nankin	Aſia	China	32 4 40 N	118 47 0 E.
Naples	Europe	Italy	40 50 15 N.	14 17 30 E.
Niagara	Amer.	Canada	43 4 25 N.	79 7 51 W.
Nice	Europe	France	43 41 47 N.	7 16 22 E.
Nootka Sound	Amer.	Pacific Ocean	49 36 6 N	126 42 30 W.
North Cape	Europe	Lapland	71 10 0 N.	25 57 0 E.
Oporto	Europe	Portugal	41 10 0 N.	8 22 0 W
Paris	Europe	France	48 50 14 N	2 20 0 E.
Pekin	Aſia	China	39 54 13 N.	116 27 30 E.
Peterſburgh	Europe	Ruſſia	59 56 23 N.	30 19 0 E.
Philadelphia	Amer.	Pennſylvania	39 56 55 N.	75 13 30 W.
Prague	Europe	Bohemia	50 5 47 N.	14 24 0 E.
Quebec	Amer.	Canada	46 47 30 N.	71 10 0 W.
Quito	Amer.	Peru	0 13 17 S.	77 55 0 W.
Reſolution, I.	Aſia	Pacific Ocean	17 23 30 S.	141 45 0 W
Rhodes	Aſia	Archipelago	35 27 0 N.	28 45 0 E.
Rome	Europe	Italy	41 53 54 N.	12 29 15 E.
+ Sandwich, I.	Aſia	Pacific Ocean	17 41 0 N.	168 33 0 E.
Sebaſtian, C.	Africa	Madagaſcar	12 30 0 S.	46 25 0 E.
Senegal	Africa	Negroland	15 53 0 N.	16 31 30 W.
Siam	Aſia	India	14 20 0 N.	100 50 0 E.
Smyrna	Aſia	Natolia	38 28 7 N.	27 6 35 E.
Stockholm	Europe	Sweden	59 20 31 N.	18 3 55 E.
Suez	Africa	Egypt	29 50 0 N	33 27 0 E.
Surat	Aſia	India	21 10 0 N.	72 22 30 E.
Teneriffe	Africa	Canaries	28 17 0 N.	16 40 0 W.
Timor	Aſia	India	10 23 0 S	123 59 0 E.
Tobolſki	Aſia	Siberia	58 12 30 N.	68 25 0 E.
Tornea	Europe	Sweden	65 50 50 N.	24 12 0 E.
+ Trinidad	Amer.	Atlant. Ocean	20 15 0 S.	126 42 0 W.
Tripoli	Africa	Barbary	32 53 40 N.	13 5 15 E.
Turin	Europe	Italy	45 4 14 N.	7 40 0 E.
Upſal	Europe	Sweden	59 51 50 N.	17 38 45 E.
Uraniberg	Europe	Denmark	55 54 38 N.	12 42 44 E.
Van Dieman's Road	Aſia	Tongataboo	21 4 15 S.	174 56 24 W.
Venice	Europe	Italy	45 26 7 N.	12 22 45 E.
Verd Cape	Africa	Negroland	14 43 45 N.	17 30 45 W.
Verona	Europe	Italy	45 26 7 N.	11 18 30 E.
Vienna	Europe	Germany	48 12 36 N.	16 16 22 E.
St. Vincent, C.	Europe	Spain	37 3 0 N.	8 59 26 W.
Wardhus	Europe	Lapland	70 22 36 N.	51 6 45 E.
Warſaw	Europe	Poland	52 14 28 N.	21 0 0 E.
York	Europe	England	53 59 0 N.	1 6 4 W.
York, New	Amer.	Jerſey	40 40 0 N.	74 11 0 W.
York Minſter	Amer.	Terra del F.	55 26 20 S.	70 8 0 W.

+ Trinidad 10 N. Lat. 61 W. Lon:

+ Sandwich — — 155 W. L

SECT. III.

Of the FIXED STARS.

PHILO. HAVING ſhewn you how to find the principal places on the terreſtrial globe, I will now proceed to point out the method of finding the ſtars on the celeſtial globe.

TYRO. The ſtars are of different magnitudes, are they not?

PHILO. As the fixed ſtars appear more or leſs bright, they are ſaid to be of the first, ſecond, third, fourth, fifth, ſixth, &c. magnitude; the ſixth magnitude comprehends the leaſt ſtars which can be ſeen by the unaſſiſted eye.

TYRO. For what purpoſe do the fixed ſtars ſerve?

PHILO. The fixed ſtars ſerve as points by which we may determine the places of the planets. On this account they have been diſtributed into conſtellations, or ſets of ſtars, which from their ſuppoſed reſemblance to the figures of animals, &c. are called by the names of thoſe figures.

TYRO. How are they known on the globe?

PHILO. On the celeſtial globe the brighteſt ſtar in each conſtellation, unleſs it has ſome particular name, has generally α Alpha; the next β Beta, &c. till the Greek letters are all uſed, and then the other ſtars in that conſtellation are marked with Roman or Italic letters. The ſtars are mentioned by the Greek letter prefixed to the name of the conſtellation, as γ Draconis, or β Arietis, &c. There are alſo ſome remarkable ſtars called by proper names, as Syrius, in Canis Major; Arcturus, in Bootes, &c.

Tyro. How am I to find theſe conſtellations?

Philo. You may conſider the ecliptic as dividing the concave face of the heavens into two equal parts, called the northern and ſouthern hemiſpheres.

Tyro. But what is the zodiac, and what does it contain?

Philo. The zodiac is a zone which ſurrounds the heavens extending 8° on each ſide of the ecliptic. The zodiac contains 12 conſtellations, which bear the ſame names with the ſigns of the ecliptic, and probably coincided with them when the names were firſt given; but in conſequence of a retrograde motion which the equinoctial points have, the conſtellations ſeem to have advanced from their former ſituations, and the beginning of Aries is now almoſt a degree within Taurus when referred to the ecliptic.*

The following Tables ſhew the Conſtellations, and the number of each, including the firſt ſix magnitudes. The ſituations with reſpect to the right aſcenſion and declination, are alſo inſerted to enable you to find them on the globe.

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* See alſo Dialogue V. Sect. 2.

CONSTELLATIONS *in the* ZODIAC.

Pleiades
4 gardes

Vindemia
trix

Mesar
tim

No. of Stars	Conſtellations.	Principal Stars.					
		Names.	Mag.	Right Aſcenſion.		Declination.	
46	Aries	Arietis	2	28°	50′	22°	25′ N.
109	Taurus	Aldebaran	1	65	57	16	4 N.
94	Gemini	Caſtor	1.2	110	16	32	21 N.
75	Cancer	- - -	3	131	5	12	40 N.
91	Leo	Regulus - Deneb	1	149	17	13	2 N.
93	Virgo	Spica Virginis	1	198	31	10	2 S.
33	Libra	- - -	2	219	49	15.	6 S.
44	Scorpio	Antares	1	244	8	25	56 S.
48	Sagittarius	- - -	4	287	8	41	0 S.
58	Capricornus	Deneb Algedi	3	301	28	13	13 S.
93	Aquarius	- - -	3	328	44	1	23 S.
110	Piſces	- - -	3	27	47	1	43 N.

Libra - Stars ~~Zubenelt~~ Zubenel Genubi
— Zubenel Chamali
— Zubenha Krabi

Mesartim in Aries

Aquarius — Ancha & Situla

CONSTELLATIONS *North of the* ZODIAC.

No. of Stars	Conſtellations.	Principal Stars.					
		Names.	Mag.	Right Aſcenſion.		Declination.	
52	Caſſiopeia -	Schedar -	2	7°	10′	55°	22′ N.
12	Urſa Major -	Pole-Star -	2	11	56	88	9 N.
10	Triangulum -	- Kochab	4	25	18	28	29 N.
5	Triangulum Minus	- -	5	31	30	27	40 N.
6	Muſca -	- -	4	39	24	26	22 N.
67	Perſeus -	Algenib - Algol		~~47~~	20	49	6 N.
46	Auriga -	Capella -	1	76	18	45	45 N.
55	Lynx - -	- -	5	89	30	59	10 N.
20	Leo Minor -	- -	3	156	50	35	18 N.
105	Urſa Major -	Dubhe -	2	162	38	62	56 N.
24	Coma Berenices	- -	3	183	10	28	34 N.
23	Camelopardulus	- -	3	184	0	84	30 N.
24	Canes Venatici viz. Aſterion et Chara	- -	4	184	20	43	0 N.
3	Cor Caroli -	- -	2	188	0	40	30 N.
49	Draco -	- Etanin	3	209	39	65	26 N.
53	Bootes -	Arcturus	1	211	32	28	18 N.
11	Mons Menalus	- -	3	219	15	3	45 N.
11	Corona Borealis	Alphecca	2	230	41	27	26 N.
50	Serpens -	- -	2.3	232	45	7	5 N.
101	Hercules cum Ramo et Cerbero -	Raſ. Algiatha	3	255	21	14	38 N.
67	Serpentarius ſive Ophiuchus -	Raſ. Alhagus	3	260	23	12	43 N.
7	Taurus Poniatowſki -	- -	4	267	50	1	15 N.
8	Scutum Sobieſki	- -	4	276	0	8	45 S.
24	Lyra - -	Vega -	1	276	57	38	55 N.
39	Vulpecula et Anſer -	- -	5	289	30	24	0 N.
13	Sagitta -	- -	4	291	47	17	22 N.
29	Aquila -	Alcair -	1	294	7	8	18 N.
18	Delphinus -	- -	3	306	33	15	9 N.
73	Cygnus -	Deneb. Adige	1.2	308	3	44	32 N.
12	Equuleus -	- -	4	315	19	4	7 N.
40	Cepheus -	Alderamin	3	316	54	61	39 N.
12	Lacerta -	- -	5	322	30	48	30 N.
81	Pegaſus -	Markab	2	342	50	14	0 N.
66	Andromeda - -	Alpheratz	2	358	38	27	52 N.

Kochab

Mioth alcor

Benetnasch

Mirach

Alkalurops

Marsic

or

Aride

Scheat

Algenib

+ Ursa Minor

an Mirach

CONSTELLATIONS *South of the* ZODIAC.

No. of Stars	Constellations.	Principal Stars.						
		Names.	Mag	Right Ascension.		Declination.		
13	Phœniz - -	- -	2	3°	58′	43°	29	S.
12	Officina Sculo.	- -	4	11	50	31	0	S.
72	Eridanus -	Achernar	1	21	38	58	21	S.
10	Hydrus - -	- -	3	28	30	63	0	S.
cra 80	Cetus - -	Menkar -	2	42	49	3	10	S.
14	Fornax Chemica	- -	3	45	35	30	30	S.
12	Horologia -	- -	4	61	0	43	20	S.
10	Reticulus Rhom.	- -	3	63	42	63	1	S.
7	Xippias -	- -	3	66	57	55	31	S.
16	Cela Praxitellis	✓ - -	3	68	25	43	0	S.
25	Lepus - -	- -	2	80	0	18	0	S.
10	Columba Noachi	- -	2	83	0	34	12	S.
igel ~~93~~	Orion - -	Betelgeule	1	85	0	7	0	N.
48	Argo Navis -	Canopus -	1	94	49	52	35	S.
29	Canis Major -	Syrius -	1	99	0	16	25	S.
8	Equuleus Pic. -	- -	4	102	0	60	0	S.
30	Monoceros -	- -	3	105	6	0	—	S.
14	Canis Minor -	Procyon -	1	112	4	5	47	N.
10	Camelion -	- -	4	127	0	74	30	S.
4	Pyxis Nautica	- -	3	128	20	33	15	S.
7	Piſces Volans -	- -	4	134	30	65	0	S.
53	Hydra - -	Cor Hydræ	2	139	18	7	43	S.
4	Sextans - -	- -	6	148	30	0	30	N.
3	Machina Pneumatia -	- -	5	151	35	30	30	S.
10	Robur Carolinum	- -	2	159	13	58	34	S.
11	Crater - -	Alkes - -	4	162	23	17	7	S.
8	Corvus - -	- -	3	179	23	23	32	S.
6	Croſiers - -	- -	2	183	45	61	52	S.
4	Muſca - -	- -	4	186	12	67	56	S.
11	Apis Indica -	- -	5	213	30	77	45	S.
4	Cercinus -	- -	3	216	25	63	59	S.
36	Centaurus -	- -	1	216	26	59	57	S.
36	Lupus - -	- -	3	217	0	46	27	S.
12	Quadra Euclidis	or Norma	4	243	45	35	0	S.
5	Triangulum Aust.	- -	3	246	38	68	36	S.
9	Ara - -	- -	3	258	54	49	41	S.
9	Teleſcopium -	- -	3	273	0	45	30	S.
12	Corona Aust.	- -	4	283	20	40	0	S.
14	Pavo - -	- -	2	302	13	57	23	S.
12	Indus - -	- -	3	305	39	48	1	S.
10	Microſcopium	- -	5	309	0	35	0	S.
43	Octans Hadley	- -	5	309	35	78	0	S.
14	Grus - -	- -	2	328	44	48	1	S.
9	Toucan - -	- -	3	330	59	61	8	S.
15	Piſces Aust. -	Formahaut	1	341	29	30	47	S.

5

Cela Sculptorial the same as
ela Praxitellis – the Graver.

DIALOGUE V.

Between PHILO, *a Tutor, and* TYRO, *his Pupil, concerning the nature, properties, and uſe of the* GLOBES.

SECT. I.

TYRO. WHAT is a globe, or ſphere?

PHILO. A globe, or ſphere, is a ſolid round body, contained under one ſurface; having a point in the middle, called the centre, from whence all lines drawn to the ſurface are equal. Half a globe, or ſphere, is called a hemiſphere.

TYRO. How many ſorts are there?

PHILO. Two, one called the terreſtrial, or earthly; the other the celeſtial, or heavenly globe.

TYRO. What does the terreſtrial globe teach us?

PHILO. By the terreſtrial globe we are taught the knowledge of the earth and ſea; with the ſituation of places, their difference of latitude and longitude; the ſun's riſing and ſetting; the length of days and nights throughout the year, and the true diſtance from one place to another. This is called Geography.

TYRO. Is the terreſtrial globe an artificial repreſentation of the earth?

Philo. It is, having the whole ſurface of the land and ſea drawn upon it, in their natural form, order, and ſituation. The ſpindle on which the globe turns is called its axis, which in the artificial globe is real; in the natural it is only imaginary.

Tyro. What are the poles and the circles?

Philo. The two extreme points of the earth's axis are called its poles, viz. north and ſouth. The earth is ſuppoſed to be ſurrounded with ſeveral imaginary circles, which are either drawn upon the globe, or expreſſed by the wooden and braſs work about it. Theſe circles are divided into the greater and leſſer.

Tyro. What is the uſe of the celeſtial globe?

Philo. The celeſtial globe not only teaches us the ſun's riſing and ſetting, but alſo the riſing and ſetting of the ſtars, together with their right aſcenſion, declination, amplitude, azimuth, latitude, longitude, and diſtance from each other. This is called aſtronomy.

Tyro. You will not ſay that the celeſtial globe is ſo juſt a repreſentation of the heavens, as the terreſtrial globe is of the earth?

Philo. Certainly not: for the ſtars are drawn on a convex ſurface, whereas they naturally appear in a concave one. But if the globe were made of glaſs, then to an eye placed in the centre, the ſtars which are drawn upon it would appear in a concave ſurface, as they do in the natural heavens.

As the terreſtrial globe, by turning on its axis, repreſents the real diurnal motion of the earth, ſo the celeſtial globe, by turning on its axis, repreſents the apparent diurnal motion of the heavens.

SECT. II.

A further Deſcription of the GLOBES, *with the great Circles and Appendages belonging to them.*

TYRO. WHAT do you mean by the great circles of the ſphere?

PHILO. Great circles are ſuch as cut the globe into two equal parts, paſſing through the centre; all ſuch as do not cut the ſphere into two equal parts, are called leſſer circles.

TYRO. Pray how many great circles are there?

PHILO. 1. The Equator, or Equinoctial. 2. The Ecliptic and Zodiac. 3. The Brazen Meridian. 4. The Horizon. And 5. The Colures.

1. *Of the* EQUATOR.

TYRO. What is the equator, or equinoctial?

PHILO. The equator on the terreſtrial, or equinoctial on the celeſtial globe, is a line, or circle, that cuts the globe into two equal parts, called the northern and ſouthern hemiſpheres, whoſe poles are thoſe of the world, dividing the N. from the S. It is divided into 360 equal parts, called degrees, beginning, on the celeſtial globe, at the firſt meridian (or ſign Aries), and is marked from 1 with 10, 20, 30, 40, &c. to 360, quite round. The firſt meridian on the terreſtrial globe was formerly fixed at the iſland of Ferro; but now almoſt every nation fixes it at or near its own metropolis.

Tyro. But there are other figures on the lower edge of the equator on the terreſtrial globe; are there not?

Philo. On moſt globes the degrees on the equator are alſo marked from the meridian of London, with 10, 20, 30, &c. to 180 degrees to the right hand, or E. and, in like manner, towards the left hand from London, with 10, 20, 30, &c. to 180, W.

Tyro. And pray what is the uſe of this?

Philo. The degrees on the equator ſhew the longitude of any place, either E. or W. from the firſt meridian. On the celeſtial globe the upper line of figures on the equinoctial ſhews the right and oblique aſcenſion of the ſun, or any ſtar.

2. *Of the* Ecliptic *and* Zodiac.

Tyro. Which is the ecliptic?

Philo. The ecliptic is another great circle of the ſphere. It cuts the equator in the two points Aries and Libra, making an angle at each point of 23 degrees, 30 minutes, which is its farthermoſt, or utmoſt extent, either N. or S. from the equator, as you will ſee more plainly hereafter.

Tyro. What is the zodiac?

Philo. The zodiac is a broad imaginary circle, which extends itſelf about eight degrees on each ſide of the ecliptic, and is that which contains the 12 ſigns. In this the planets perform their revolutions. The line in the middle of the zodiac is called the ecliptic. It is called alſo the ſun's path, or way. But in aſtronomy, it is that circle or path which the earth would deſcribe to an eye, placed in the centre of the ſun.

TYRO. Pray, Sir, tell me in what manner the ecliptic is divided, for, I think, I have ſome notion of it.

PHILO. The ecliptic (like the equator) is divided into 360 degrees, but not numbered from 1, 10, &c. as the equator is. It is divided into 12 equal parts, containing 30 degrees each, which are called ſigns, and have different names and characters.

TYRO. Pleaſe to let me know them.

PHILO. I will; and you ſhould get the names of them by heart, and the character belonging to each, ſo as to know them at firſt ſight.

The SIGNS.

NORTHERN SIGNS.*

Aries.	*Taurus.*	*Gemini.*	*Cancer.*	*Leo.*	*Virgo.*
♈	♉	♊	♋	♌	♍

SOUTHERN.

				♒	♓
Libra.	*Scorpio.*	*Sagittarius.*	*Capricornus.*	*Aquarius.*	*Pisces.*
♎	♏	♐	♑	⚹	⚹

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* Take notice, the firſt ſix are called the Northern, the other the Southern Signs; and you are to obſerve which are oppoſite to each other, as ♈ is oppoſite to ♎, ♐ to ♊. &c. for it will ſhew you the different times and ſeaſons of the year, &c. very readily when you come to perform any operation.

Tyro. I will obſerve what you ſay; but pleaſe to tell me the ſignification of their names.

Philo. It is of no great ſervice; however, here they follow: Aries ♈, or the Ram; Taurus ♉ the Bull; Gemini ♊ the Twins; Cancer ♋ the Crab; Leo ♌ the Lion; Virgo ♍ the Virgin; Libra ♎ the Balance; Scorpio ♏ the Scorpion; Sagittarius ♐ the Archer; Capricornus ♑ the Goat; Aquarius ♒ the Waterbearer; and Piſces ♓ the Fiſhes.

Tyro. Pray, Sir, inform me why the ancient aſtronomers affixed ſuch images as the Ram, the Bull, &c. to the 12 ſigns of the zodiac.

Philo. It is not eaſy to give a poſitive anſwer to your queſtion; but there is great reaſon to ſuppoſe that they were placed as hieroglyphics of the ſeaſons of the year, alluding to the annual courſe of the ſun.

Thus, Aries, Taurus, and Gemini, repreſent March, April, and May, the ſpring quarter of the year, when lambs, calves, and goats, (the latter generally bringing forth twin kids) are produced.

Cancer, the Crab, which creeps both ways, repreſents the increaſe and decreaſe of the ſun's declination, to and from the ſummer ſolſtice, in June.

Leo, the Lion, intimates the raging heat of the ſun in July, which the ancients compared to the furious nature of that fierce animal.

Virgo, the Virgin, with a ſpike or ear of corn in her hand, properly repreſents Auguſt, when the harveſt of the earth is ripe.

Libra, the Balance, is diſplayed in September, to intimate that the days and nights, at the autumnal equinox, are equal in all parts of the globe.

Scorpio, the Scorpion, a noxious animal, is placed as the hieroglyphic of October; becauſe at that ſeaſon, diſeaſes of various kinds were ſuppoſed to rage.

Sagittarius, the Archer, marks November, as the proper time for hunting.

Capricornus, the Goat, by its climbing up the rocks, is placed as an emblem of December, when the ſun, at the winter ſolſtice, begins to aſcend again towards the equinoctial.

Aquarius, the Water-bearer, with his urn, repreſents January, when rains are frequent.

Piſces, the Fiſhes, are emblems of the fiſhing ſeaſon, which began in the Nile during the month of February.

N. B The ecliptic cuts, or interſects the equator, or equinoctial, at the two points, or ſigns, Aries ♈ and Libra ♎, viz. on the 21ſt of March, and the 22d of September, N. S. on which days the ſun is in the equator, and the days and nights are then equal to all the inhabitants on the globe, as you will plainly ſee hereafter.

3. *Of the* BRAZEN MERIDIAN.

TYRO. What is the Brazen Meridian?

PHILO. The Brazen Meridian is another great circle, which divides the globe into two equal parts, called the eaſtern or weſtern hemiſpheres. It is repreſented by a thick braſs hoop, which ſurrounds the globe, from N. to S. and divides the equator into two equal parts, viz. the E. and W. and is that on which the globe itſelf is hung, or turns round upon its axis.

TYRO. How is the brazen meridian divided?

PHILO. Like the equator and ecliptic, into 360 degrees; but with this difference, it is divided into four nineties.

TYRO. In what manner, pray?

PHILO. From the equator towards the N. aud S. pole, the meridian is marked with a cypher over the equator, thus (0), and on each ſide, with 10, 20, 30, 40, 50, 60, 70, 80, and 90, which ends in each pole. Then again, from each pole to the equator on the other half of the meridian, is marked 10, 20, 30, 40, &c. to 90, which ends in the equator.

TYRO. Then I plainly perceive by this, that as many degrees as one pole is elevated or raiſed, ſo many degrees will the contrary pole be depreſſed.

PHILO. Your notion is very juſt.

TYRO. But pray what is the principal uſe of this circle?

PHILO. The graduated edge of the brazen meridian ſhews the latitude of places, and their difference of latitude, either N. or S. from the equator: for the latitude of a place is the ſame as the elevation of the pole above the horizon.—That is, in whatever figure the horizon cuts the meridian, ſo many degrees is the pole elevated, which is equal to the latitude of the place, as you will more plainly ſee, when we come to ſpeak of latitude and longitude.

4. *Of the* HORIZON.

TYRO. What is the horizon?

PHILO. The horizon is that great circle which divides the heavens and earth into two equal parts, one called the upper, and the other the lower hemiſphere. There are two ſorts, the one called the ſenſible or apparent, the other the rational or real horizon.

Tyro. What is the ſenſible horizon?

Philo. The ſenſible horizon is that which divides the viſible part of the heavens from the inviſible, and is that great circle which we ſee all round us (ſtanding upon any hill, or at ſea) juſt in the points where the heavens and earth ſeem to meet, or to be joined together.

Tyro. What is the rational horizon?

Philo. The rational horizon is that which paſſes through the centre of the earth, and divides it into the upper and lower hemiſphere.

☞ This rational horizon is repreſented by that broad wooden circle lying with its face upwards, having two notches cut in it, one in the N. and the other in the S. part, in which the Brazen Meridian may be moved up or down at pleaſure.

Tyro. Pleaſe to give me a further deſcription of the horizon?

Philo. If you uſe Mr. Jones's globes, the horizon plate will contain on its ſurface five circles.

1. The circle that is next the globe ſhews the amplitude.

2. The ſecond circle is that of azimuth, &c.

3. The third circle contains the thirty-two points of the mariner's compaſs.

4. The fifth circle is the ecliptic, and contains the marks, names, and figures of the twelve ſigns of the zodiac.

5. The fourth is that of the months and days throughout the year.

TYRO. Sir, I thank you kindly. Pray tell me now the uſe of the horizon.

PHILO. The horizon ſhews the riſing and ſetting of the ſun, length of days and nights; alſo the riſing and ſetting of the ſtars in any latitude, together with the azimuth, amplitude, almacanther, &c. of the ſun, or any ſtar, and the point they riſe and ſet upon, &c. The explanation of theſe terms we muſt defer a little longer.

5, *Of the* COLURES.

TYRO. Pray what are the Colures?

PHILO. The Colures are two great circles, cutting the equator at right angles, and paſſing through the poles of the world.

The Solſtitial Colure is that great circle which paſſes through the firſt degrees of Cancer and Capricorn, ſhewing winter and ſummer.

The Equinoctial Colure paſſes through Aries and Libra, and ſhews the ſpring and autumn.

And now, having given you a full deſcription of the great circles, I propoſe to deſcribe the leſſer, and ſhew you more of the nature of the globe, and the appendages belonging to it.

DIALOGUE VI.

Concerning the leſſer Circles of the Sphere, commouly called Parallel Circles.

SECT. I.

TYRO. WHAT do you mean by the leſſer, or parallel circles?

PHILO. All ſuch circles as do not divide, or cut the globe into two equal parts, but that cut off any ſegment, leſs than the half, are leſſer circles.

TYRO. Why are they called parallel circles?

PHILO. Becauſe they are parallel every where to the equator.

TYRO. Pray tell me the names of the leſſer circles.

PHILO. They are the tropics and polar circles.

1. *Of the* TROPICS.

TYRO. Pray what are the tropical circles?

PHILO. Look for the ſign cancer on the globe, and you will find a circle drawn with a double, or dotted line, round the globe, parallel to the equator, which is called the northern tropic, or tropic of cancer, being 23½ degrees from the equator northward, ſhewing the ſun's greateſt northern declination. Then looking for the ſign Capricorn, you will find the ſame ſort of circle, which is called the ſouthern tropic, being alſo 23½ degrees from the equator, and ſhewing the ſun's greateſt ſouthern declination, or departure from the equinoctial.

2. *Of the* POLAR CIRCLES.

TYRO. Which are the polar circles?

PHILO. They are two ſmall circles, 23½ degrees diſtant from the poles, drawn alſo with double lines: that on the N. is called the arctic circle, and that on the S. the antarctic circle.

TYRO. Pray what is their uſe, or what do we learn from them?

PHILO. All thoſe inhabitants that live under theſe lines have their longeſt day juſt twenty-four hours long, and their longeſt night the ſame. If you go further towards the poles, their days increaſe, till at the poles themſelves they have ſix months day and ſix months night, as you will find demonſtrated in the problems.

TYRO. Surpriſing! I long to ſee thoſe places, having heard of ſuch things, but always looked upon them as idle tales.

PHILO. You may depend upon the truth of what I tell you, and will ſoon ſee the reaſon of it. But, now, we will ſhew you the appendages belonging to the globes.

SECT. II.

Of the Appendages belonging to the Globes.

TYRO. WHAT do you mean by appendages?

PHILO. Appendages are a ſort of apparatus moveable and immoveable, as belonging to globes; the principal or chief of which are as follow:

1. *Of the* HOUR CIRCLE *and* INDEX.

TYRO. Pray what is the hour circle, and its uſe?

PHILO. The hour circle is a ſmall circle of braſs, divided into twenty-four hours; the upper twelve repreſents noon, and the lower twelve midnight. It is ſcrewed on the meridian round the N. pole, and on the pole itſelf is placed the index, or hand, which turns round the globe.*

Its uſe is to tell the time of the riſing and ſetting of the ſun or ſtars, in any latitude, and what o'clock it is at any given time in any part of the world, &c.

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* For the greater conveniency of elevating the ſouth pole, and viewing the New Diſcoveries, many of the modern globes have the hour circle placed on the ſurface of the globe, under the braſs meridian, and not on the meridian, as above deſcribed.

2. *Of the* QUADRANT *of* ALTITUDE.

TYRO. Pray what is the quadrant of altitude?

PHILO. This is a thin piece of pliable braſs, divided into 90 degrees, anſwering to the degrees of the equator, beginning at the lower end with (0) and proceeding to 10, 20, 30, &c. till we come to 90: at which figure it has a nut, which ſlips upon the meridian at pleaſure, and is faſtened to it by a ſcrew.

TYRO. Pray what is the chief uſe of it?

PHILO. Its uſe is to tell the height of the ſun or ſtars, at any hour, and their bearings; alſo the diſtance of places from one another on the terreſtrial globe, &c. &c. &c.

3. *Of the* MARINER'S COMPASS.

TYRO. What is the mariner's compaſs, and its uſe?

PHILO. This is an inſtrument uſed in navigation, having the 32 points of the wind marked, or drawn on a card, and a needle being touched with the loadſtone, points always northward, or nearly ſo. This compaſs is ſometimes fixed in the bottom of the frame, under the centre of the globe, for the purpoſe of placing the globe in a right poſition, viz. ſo that the four cardinal points of the horizon may be directed towards their correſponding points in the heavens.

SECT. III.

Concerning the different Names of the Sphere, *according to its different Poſition or Situation.*

PHILO. THERE are three ſorts of ſpheres, viz. a parallel, a right, and an oblique ſphere.

A PARALLEL SPHERE is ſo called, becauſe in that the equator coincides, or is parallel with the horizon; and the poles are in the zenith and nadir.

TYRO. What do you mean by the zenith and nadir?

PHILO. The point in the heavens juſt over our head, is the *zenith*, and the oppoſite point to it, juſt under our feet, is called the *nadir*.

Properties of a parallel Sphere. The inhabitants of the parallel ſphere are thoſe, if any, that live at the poles, who have but day and one night in the year. This day continues ſix months, while the ſun paſſes through ſix of the ſigns of the zodiac; and the night ſix months, while he paſſes through the other ſix. The day to thoſe who live at the north pole begins when the ſun enters Aries, and continues till he reaches Libra; when night commences, and continues the other ſix months. Thoſe who live under the ſouth pole experience the direct contrary, it being day with them when it is night with the former, and *vice verſa.* But both enjoy a long continuance of twilight, both after the ſun has departed, and before he appears.

TYRO. Pray, Sir, what do the polar inhabitants (if there be any) obſerve with reſpect to the ſun, moon, and ſtars?

PHILO. 1. They ſee the ſun, for half the year, moving continually round above the horizon, in a ſpiral line, the firſt round ſkimming the ſkirts of the horizon; the ſecond higher, and ſo on, till by about 90 revolutions he has reached the tropic, his utmoſt declination; after which, by 90 more revolutions, he again reaches the horizon, and then their long winter's night begins.

2. They ſee the moon during their ſummer's day only as a white cloud in the ſky; and in the winter, during her ſecond and third quarters, ſhe moves as the ſun did, round and round for a continuance of ſeveral days without ſetting; being a fortnight above, and a fortnight under the horizon.

3. They can only ſee that hemiſphere of ſtars between the pole and the equator, the feweſt ſeen by any of the inhabitants of the earth. During half a year they ſee none, (the ſtars being ſwallowed up in the ſuperior light of the ſun), and their view of them is but ſhort in the winter's night, by reaſon of the long twilight. To them the ſtars never ſet, but move in circles parallel to the horizon, keeping always the ſame altitude. The planets are half their time above, and half below the horizon.

A RIGHT SPHERE is ſo called, becauſe in that, the equator cuts the horizon at right angles; the poles will lie, or be in the horizon; and the equator will be in the zenith and nadir.

Properties of a right Sphere. The inhabitants of this ſphere are thoſe who live at the equator, and have their days and nights equal, viz. twelve hours each; becauſe not only the equator, but alſo its parallels, are cut into two equal parts by the horizon.

TYRO. How do the ſun, moon, and ſtars appear to the inhabitants at the equator?

PHILO. The ſun riſes and ſets nearly perpendicular, nor can he have more than 23 degrees, 30 minutes, either north or ſouth amplitude. He comes to the meridian with the ſame degree of the equator with which he roſe; and hence there can be no aſcenſional difference. He is half a year on one ſide of the zenith, and as much on the other; paſſing over their zenith twice a year, viz. at the equinoxes.

With regard to the moon, there is nothing uncommon, or different in her appearances, from thoſe in an oblique ſphere, except her riſing and ſetting nearly in a perpendicular direction like the ſun.

But here is a glorious diſplay of all the ſtars in the heavens, from pole to pole; all of them riſing and ſetting perpendicular to the horizon, except the pole ſtars, which lying in the horizon, are rendered inviſible by the denſeneſs of the atmoſphere. The twilight is ſhorter in this ſphere than in any other, for the ſame reaſon that it is ſhorteſt with us at the equinoxes.

An OBLIQUE SPHERE is that poſition of the globe, which all the inhabitants of the earth, excepting thoſe at the poles and equator, enjoy; and is ſo called, becauſe under it the equator cuts the horizon obliquely.

Properties of an oblique Sphere. 1. The pole being elevated to any degree leſs than 90, the axis of the earth always makes an acute angle with the horizon.

2. All the parallels to the equator cut the horizon obliquely, and conſequently produce an inequality in the days and nights. Theſe are never equal but when the ſun is in the firſt of Aries and Libra, which happens in March and September, when he moves in the equator, making equal days and nights to all the inhabitants of the earth, except to thoſe at the poles.

3. The inhabitants of this ſphere, who live without the tropics, never have the ſun in their zenith, though they may ſometimes ſee the moon there, on account of her latitude; but *under* the tropics the ſun is vertical once, and to every place *between* the tropics and the equator, it is vertical twice every year.

4. The ſtars riſe and ſet obliquely in this poſition; and the nearer the obſerver is ſituated to the equator the greater number of them will be viſible. The length of the twilight is longer or ſhorter in this poſition, according as the latitude is greater or leſs.

5. The moon, when at full, being always in an oppoſite ſign to the ſun, muſt, in ſummer, be in the winter ſigns, and conſequently make a ſhort, low courſe. But in winter ſhe will move through the ſummer ſigns, making a high, long circuit; which is of great uſe in that dreary ſeaſon.

SECT. IV.

Of the different Names of the Inhabitants of the Globe, *with reſpect to their Situation.*

Tyro. YOU have already explained to me the three different poſitions of the ſphere; pray, what do you mean by the names of the ſeveral inhabitants?

Philo. Theſe inhabitants have different names according to the ſeveral meridians and parallels of latitude they lie under, without any regard to the different poſitions of the ſphere.

Tyro. Pleaſe to tell me their different names.

Philo. There are ſix different kinds of inhabitants:—1. Antœci. 2. Periœci. 3. Antipodes. 4. Amphiſcii. 5. Periſcii. And 6. Heteroſcii.

Tyro. Who are the Antœci?

Philo. The Antœci are thoſe inhabitants that have the ſame longitude with us, that is, lie under the ſame meridian; but they are as far to the S. of the equator as we are to the N. Their hour is the ſame as ours, it being noon, &c. with both at the ſame time. Their days are equal to our nights, and *vice verſa*; and their ſummer is our winter.

Tyro. What do you mean by the Periœci??

Philo. The Periœci are thoſe that lie under the ſame parallel of latitude with us, on the ſame ſide of the equator, only are diſtant 180 degrees of longitude. They have contrary hours; it being noon with them when it is midnight with us. Their days and nights are of the ſame length as ours; and their ſeaſon, or time of the year, is alſo the ſame as with us.

TYRO. Which are the Antipodes?

PHILO. The ANTIPODES to us are ſuch inhabitants as have the ſame latitude S. as we have N. but differ 180 degrees in longitude. That is, they and we have oppoſite parallels, and oppoſite meridians. Their hour is directly the reverſe of ours, it being noon with them when it is midnight with us. Their longeſt day is our ſhorteſt day, and their longeſt night our ſhorteſt night; and the four ſeaſons are contrary, their ſummer being our winter, &c. &c.

TYRO. It is wonderful indeed! I have often heard that there are ſuch perſons as walk with their feet to our feet (that is, go with their heads downwards in reſpect of us:) pray are not the Antipodes this ſort of people?

PHILO. They are, and however ſtrange it may ſeem, it is certainly true; and this you will eaſily comprehend when you come to the problems.

The other diviſions derive their names from the different poſitions of their ſhadows.—

TYRO. What is meant by the AMPHISCII?

PHILO. They are ſo called, becauſe their ſhadows are caſt different ways, at noon, at different times of the year; that is, their ſhadow ſometimes points to the north, and ſometimes to the ſouth. Therefore it is eaſy to perceive that theſe people live between the tropics.

TYRO. Who are the Periſcii?

PHILO. The PERISCII are ſo called becauſe their ſhadows go quite round them. Such are the inhabitants that dwell within the polar circles, that is, from 66½ degrees of latitude to 90, where the ſun for part of the year never ſetting, but moving round the horizon, makes the ſhadows of the people likewiſe move around them.

TYRO. What is meant by the Heteroſcii?

PHILO. The HETEROSCII are ſo called, as having their ſhadow + caſt but one way, that is, either always towards the N. or always towards the S. Theſe are ſuch as live between the tropics and the polar circles. Thoſe in the ſouthern hemiſphere have their ſhadows caſt always ſouthward; and thoſe in the northern hemiſphere have their ſhadows always caſt northward, as in England, France, Spain, and moſt other parts of Europe.

+ at 12 oclock or noon-day

SECT. V.

Of the ZONES *and* CLIMATES.

PHILO. THE ſurface of the earth is divided alſo into zones and climates.

TYRO. What do you mean by the zones?

PHILO. A zone, or girdle, is a tract, or ſpace, that ſurrounds the ſurface of the earth, as a belt, or girdle, does the body.

TYRO. How many zones are there?

PHILO. Five; viz. one torrid, two temperate, and two frigid zones.

TYRO. Pray tell me the extent of theſe, that I may have a better idea of the diviſion of the globe.

PHILO. You remember I told you that from the equator to either pole is 90 degrees; therefore, from the N. to the S. Pole is 180 degrees. Obſerve then,

1. The TORRID Zone extends from the equator to the tropic of Cancer northward, and to the tropic of Capricorn ſouthward, 23½ degrees each way, viz. 47 degrees in all.

2. The TEMPERATE Zones extend themſelves from the two tropics to the polar circles on both ſides of the equator; each of them containing 43 degrees, making 86 degrees together.

3. The FRIGID Zones extend from the polar circles to the poles, being each 23½ degrees, or

47 together; for 23½, 43, and 23½, make 90 degrees, the diſtance from the equator to either pole. Or rather thus, the torrid zone contains 47 degrees, the temperate zones 86, and the frigid 47, in all 180 degrees.

Tyro. Sir, I thank you for this explanation; it is very eaſy to be underſtood: pleaſe, now, to tell me what you mean by the climates?

Philo. Climates are tracts, or circles upon the ſurface of the globe, parallel to the equator, of ſuch a certain breadth, that the artificial day in each (viz. from ſun-riſe to ſun-ſet) exceeds that in the next climate nearer the equator by half an hour, till you come to the polar circles, and then, indeed, the day increaſes in each climate by one entire month.

Tyro. How many climates* are there that differ by the half hour, and how many by the entire month?

Philo. There are 60 climates in all, viz. 30 on each ſide of the equator, called accordingly north and ſouth: of theſe 60, 48 extend from the equator to the polar circles, and each differs by half an hour. And the remaining 12 are contained between the polar circles and the poles, each differing one entire month from the other.

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* Great Britain extends from the middle of the 9th to about the middle of the 13th north climate, viz. about four climates. —See Table of Climates North of the Equator, p. 12 and 13. In the fourth column of that Table, instead of D. M. read H. M. meaning Hours and Minutes, shewing the length of the longest day in each climate; read also 12h. 30m. instead of 12° 30′, and in the other columns read 25′ instead of 25°. In the second and third columns D. M. mean degrees and minutes.

DIALOGUE VII.

An Explanation of the moſt common Terms uſed in Geography *and* Aſtronomy.

TYRO. YOU ſaid a few days ago that you would explain what you meant by the words Amplitude, Azimuth, &c. &c.

PHILO. I did; and this is a proper time to do ſo, before we enter more immediately on the uſe of the globes. And I aſſure you that if you underſtand and will commit to memory the meaning of theſe terms, there will remain but little difficulty in working the ſeveral problems which I ſhall go over with you.

1. Zenith, as I have already told you, is that point of the heavens which is directly over our head.

2. Nadir, is that point under our feet, being directly oppoſite to the Zenith.

3. Zenith Diſtance, is the number of degrees that the ſun, or any ſtar, wants of 90 degrees, when they are upon the meridian, or greateſt height.

4. Imaginary circles, drawn through the zenith and nadir, and cutting the horizon at right angles,

are called Vertical or Azimuth Circles. Hence the diſtance of any heavenly body from the meridian or *ſouth* point of the heavens, meaſured by degrees upon the horizon, is called the AZIMUTH. Sometimes the Azimuth is reckoned from any of the cardinal points.

5. The Azimuth of the ſun, or a ſtar, from due eaſt or weſt, at the time of its riſing and ſetting, is called its AMPLITUDE.

6. The ALTITUDE of any heavenly body is its height above the horizon. MERIDIAN ALTITUDE is its greateſt height at 12 o'clock, and when it reaches that height it is ſaid to *culminate.*

7. DECLINATION, is the diſtance of the ſun, or any ſtar, from the equator or equinoctial, counted on the brazen meridian in degrees, and is called north, or ſouth, according to the ſide of the equinoctial on which the declination is. Therefore the ſun's declination at any time is the ſame as the latitude of the place on earth to which he is then *vertical*; conſequently all *parallels of declination*, on the celeſtial globe, are the ſame as *parallels of latitude* on the terreſtrial.

8. RIGHT ASCENSION, is an arch of the equinoctial, contained between the ſign Aries ♈, and the degree of the equinoctial that is cut by the brazen meridian, when the ſun, or ſtar, is brought to the meridian. Conſequently right aſcenſion on the celeſtial globe is the ſame as longitude on the terreſtrial.

9. OBLIQUE ASCENSION, is that arch of the equinoctial contained between the ſign ♈, and the degree of the equinoctial, which is cut by the horizon at the riſing of the ſun, or ſtar.

10. OBLIQUE DESCENSION, is juſt the reverſe, being that arch of the equinoctial, contained be-

tween the ſign Aries and the degree of the equinoctial, that is cut by the horizon, at the ſetting of the ſun, or ſtar.

11. ASCENSIONAL DIFFERENCE, is the difference of degrees between the right and oblique aſcenſion, which converted into time, by allowing 15 degrees for every hour, ſhews how much the ſun, or ſtar, riſes, or ſets, before or after ſix. That is, ſubtract the leſs from the greater number, and the remainder will give the aſcenſional difference. In a right ſphere the ſun always riſes at ſix o'clock.

12. ALMACANTHERS, are circles or parallels of altitude paſſing through every degree and minute of the meridian, parallel to the horizon.

13. The Elevation of the Pole is the ſame as Latitude. Of this there are three ſorts, viz.

1. The LATITUDE OF A PLACE is its diſtance from the equator, either north or ſouth, numbered in degrees on the brazen meridian: or, in other words, it is the elevation of the pole above the horizon.

2. Latitude (in Navigation) is the diſtance of a ſhip from the equinoctial, counted on the meridian. So that if a ſhip ſails towards the equinoctial, ſhe is ſaid to depreſs the pole; and, if ſhe ſails from the equinoctial, ſhe is ſaid to raiſe the pole.

3. Latitude of a Star, is its diſtance from the ecliptic, being an arch of a circle of longitude, reckoned from the ecliptic towards its pole either N. or S.

The ſun, therefore, being always in the ecliptic, has no latitude.

14. LONGITUDE is alſo of three ſorts, viz.

1. LONGITUDE OF A PLACE, is an arch of the equator, intercepted between the firſt meridian on the equator and the meridian of the place.

2. The Longitude of a Star is an arc of the ecliptic intercepted between the firſt point of Aries, and the circle of latitude which paſſes through the ſtar: this is reckoned eaſtward only. The ſun's place in the ecliptic is called its longitude, but it is uſually expreſſed by the degree and minute of the ſign in which it is.

Longitude and Latitude, therefore, on the celeſtial globe bear the ſame relation to the *Ecliptic* as they do on the terreſtrial globe to the *Equator*.

3. Longitude (in Navigation) is an arch of the equator, contained between the firſt meridian and the meridian the ſhip is on.

DIALOGUE VIII.

Containing ſome uſeful and neceſſary Problems *on the* Terreſtrial Globe.

N.B. (°) ſtands for degrees, (′) for minutes.

SECT. I.

PHILO. YOU ſay, TYRO, that you underſtand what I have ſhewn you concerning the nature of the globes, and the appendages that belong to them; if ſo, you are fit for the following problems: but, if you think you are not perfectly maſter of theſe ſubjects, and do not underſtand what right aſcenſion, oblique aſcenſion, azimuth, almacanthers, &c. ſignify, or do not know what the greater or leſſer circles are, and the particular uſes of the meridian, horizon, colures, quadrant of altitude, &c. then, pray, turn back, and read them over once more; for you will find that your underſtanding theſe will be a great help to you in the ſolution of geographical problems.

TYRO. I thank you for your care; but I underſtand them in general very well.

PHILO. Then I will directly proceed to

PROB. I.

The Latitude of any Place being given, to rectify the Globe for that Place.

Definition.—I have already told you, that the latitude of any place is the ſame thing as the elevation of the pole above the horizon; therefore whatever the latitude be, ſuppoſe that of London 51° 32′ N. or that of Madrid 40° 25′ N. proceed thus:

Turn the pole on which the dial-plate is fixed towards the north part of the horizon, ſlipping or moving the whole globe backwards or forwards, in the notches of the horizon, till the horizon cuts the brazen meridian, in 51° 32′ (viz. a little more than 51½) ſo will the globe be rectified for the latitude of London; that is, the N. pole will then be elevated 51° 32′ above the horizon; and London being brought to the meridian itſelf, will then be in the zenith, at an equal diſtance from all parts of the horizon.

Depreſs the pole till the horizon cuts the brazen meridian at 40° 25′, and you will then have the poſition of the inhabitants at Madrid; and turning the globe, till Madrid comes to the meridian, you will find it in the zenith, or top of the globe, under 40° 25′.

If it were required to rectify the globe for S. latitude, then you muſt elevate the S. pole to the given latitude inſtead of the N. pole; but this is better explained by the third ploblem.

Tyro. How am I to find the latitude of any place, as of Pekin in China, or of Batavia?

Philo. Bring the place on the globe to the graduated edge of the brazen meridian, and the degree marked on the meridian over it ſhews the degree of latitude.

Tyro. Then Pekin is almoſt 40° N. latitude, and Batavia in Java is about 6° South.

Philo. You are right: find the latitude of Abo; Alexandria; Athens; Bagdad; Berlin; Cape Bojador; Botany Bay; Calcutta; Canton; Cayenne; Conſtantinople; Copenhagen; Dunkirk; Eaſter Iſland; Edinburgh; Ferro Iſle; and Geneva.

PROB. II.

To find the Longitude of any Place.

Rule.—BRING the place to the brazen meridian, and the degree of the equator then under the meridian, ſhews its longitude. Thus the longitude of Pekin is about 116½° Eaſt long. and that of Liſbon is 9° Weſt.

Tyro. Of what place are theſe cities Eaſt and Weſt?

Philo. Of London, or rather Greenwich; for almoſt all countries reckon longitude from the capitals of thoſe countries, or from the obſervatories belonging to them; thus on Engliſh globes the firſt meridian is placed at Greenwich, which is only 5½ minutes of a degree Eaſt of St. Paul's Church in London. In Spain they reckon from Madrid;—in France from Paris. Formerly all European nations had a common ſtandard, and reckoned from the Ferro Iſlands (perhaps becauſe theſe were the moſt weſterly places then known) being about 18° Weſt of London.

Tell me now what is the longitude of Genoa; Gibraltar; Glaſgow; Guadaloupe; the Hague; St. Helena; Holyhead; Jeruſalem; Iſpahan; Land's End; Leghorn; Liſbon; and Liverpool.

PROB. III.

The Latitude and Longitude of any Place being given, to find the Place.

BRING the given longitude to the meridian, and then the place will lie under the given degree of latitude in the meridian.

Ex.—There are two places; one has 18° 00′ N. latitude, and 77° 00′ W. longitude. The other has 34° 29′ S. latitude, and 18° 30′ E. longitude from London; I demand what places theſe are?

Rule.—For the firſt place, I elevate the N. pole to 18° 00′, becauſe it is 18° 00′ N. latitude. Then I turn the globe to the right hand, or eaſtward (becauſe the place lies weſtward) till 77° 00 upon the equator, counted from the meridian of London, paſſes under the meridian; when I look under the latitude 18° 00′ (which is in the zenith) on the meridian on the top of the globe, and under that degree on the meridian, I find Port Royal, or Kingſton, in Jamaica, the place required.*

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* Kingſton being now conſidered as the capital of Jamaica, it is inſerted on moſt modern globes inſtead of Port Royal; but the difference of their ſituation is ſo trifling as not ſenſibly to affect the reſult of the problem.

For the ſecond place, I elevate the S. pole (though there is no occaſion to elevate the pole barely to find a place; but it is better to do ſo, becauſe you have then the real ſituation of the inhabitants) to the given latitude 34° 29′, and then turn the globe to the left hand, or weſtward, till 18° 30′ E. longitude from London come under the meridian. Then I look under the latitude 34½° on the meridian, and juſt under this I find the Cape of Good Hope, the place required.

What are the places ſituated in about 6° N. lat. and 55½° W. long.?—in 34½° S. lat. and 18½° E. long.?—in 52° N. lat. and 13½° W. long.?—in 12° S. lat. and 38½° W. long.?

PROB. IV.

The Latitude of any Place being given, to tell all thoſe Places that have the ſame Latitude.

Def.—All thoſe places that have the ſame latitude, have the days and nights of the ſame length, at the ſame time; but not the very ſame hour of the day.—See Dial. VI. Sect. IV. Def. 2.

Rule.—Bring the given place to the meridian (ſuppoſe Madrid, in Spain, 40° 25′ N.) then turn the globe, and all thoſe places that paſs under 40° 25′, have the ſame latitude as Madrid; which you will find to be Pekin, in China; Samarcand, in Tartary; Naples, in Italy; and Philadelphia, in America, nearly; for a few minutes are not to be regarded in ſuch caſes.

Ex.—Enumerate the principal places that have the ſame latitude as Conſtantinople; alſo the places that have the ſame, or nearly the ſame latitude as the northern part of the iſland Mauritius.

PROB. V.

To tell the Difference of the Latitude of Places.

HERE are properly two queſtions, and conſequently two anſwers. Firſt, if the latitudes be both N. or both S. then ſubtract the leſs from the greater latitude, and the remainder is the difference or anſwer. Thus between London and Madrid is 11° 7′, the firſt being 51° 32′, and the other 40° 25′. And between Candy in Ceylon, and Stockholm, is 51° 26′, for Stockholm is about 59° 20′ N. and Candy 7° 54′ N.

Secondly, If one place lie on the N. and the other on the S. ſide of the equator; that is, if one be in N. and the other in S. latitude, then add them both together, and their ſum is the difference of the latitude required.

Thus Copenhagen is 55° 41′ N. and Botany-Bay 33° 50′ S. theſe added together make 89° 31′, the difference required.

Ex.—What is the difference of latitude between Paris and Madrid?—Amſterdam and Batavia?—the Cape of Good Hope and Cape Horn?—Bengal and St. Helena?—and between Pekin and Philadelphia?

PROB. VI.

The Longitude of any Place being given from any Meridian, to tell thoſe Places that have the ſame Longitude.

THIS is done after the ſame manner as the other, only here the anſwer will be on the equator, as the others were on the meridian.

I would know what places have the ſame longitude as London, and alſo thoſe that have the ſame longitude as Peterſburgh, in Ruſſia.

RULE.—Bring London to the meridian, then all thoſe places on the globe (from the N. pole to the S.) that lie under the edge of the meridian, have the ſame longitude as London. Thus Alençon, in France; Valencia, in Spain; Oran, in Algiers; and the Salt-mines in Africa, have the ſame, or very nearly the ſame longitude as London. Again, Conſtantinople, in Turkey; and Alexandria, in Egypt, have very nearly the ſame longitude as Peterſburgh.

Ex.—Find all thoſe places that have the ſame longitude as Liſbon; all thoſe that have the ſame longitude as Quebec, in Canada; and thoſe that have the ſame as Pekin, in China.

PROB. VII.

To tell the Difference of the Longitude of Places.

Rule.—HERE alſo there are two queſtions, and conſequently two anſwers, as in Prob. V. Firſt, If the places lie both E. or both W. of the firſt meridian, or the line you reckon the longitude from, viz. if they both have E. or both W. longitude, then ſubtract one from the other, and you have the difference.

Thus, I find Jeruſalem has 35° 25′ E. longitude from London, and Pekin 116° 30′ E. longitude; therefore I ſubtract 35° 25′ from 116° 30′, and there remains 81° 5′ difference of longitude E. or W. that is, Pekin is 81° 5′ E. longitude from Jeruſalem; or Jeruſalem is 81° 5′ W. longitude from Pekin.

Secondly, If one place have E. and the other W. longitude from the firſt meridian, (ſuppoſe London, or any other meridian), then add their longitudes together, and the ſum is the difference of longitudes required.

Ex.—I would know the difference of longitude between Jeruſalem 35° 25′ E. of London, and Port Royal in Jamaica 77° 00′ W.

Here, as one is E. and the other W. I add 35° 25′ and 77° 00′ together, and their ſum makes 112° 25′, the difference of longitude. That is, Jeruſalem is 112° 25′ E. of Port Royal, or Port Royal is 112° 25′ W. of Jeruſalem.

Ex.—Pekin, in China, is 116° 30′ E. longitude, and Port Royal is 77° 00′ W. I add theſe ſums together, and find it 193° 30′ difference of longitude; but becauſe it is more than 180°, I ſubtract 193° 30′ from 360,* and there remains 166° 30′, the true difference required.

Tyro. Sir, I heartily thank you for this explanation, which I underſtand very well.

What is the difference of longitude between Paris and Cape Horn? between Naples and Cape Fineſterre? between Liſbon and New York? and between Mecca and Calcutta?

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* *Note* 1. No place can exceed or be above 180° of longitude from another place; for 181° E. longitude is more properly 179° W. longitude; for 181° taken from 360° there remains 179°, which is nearer to the given place than 181°.

Note 2. If the difference of longitude after addition exceeds 180°, take it out of 360°, for that is the true longitude required. See *Note* 1.

PROB. VIII.

The Day of the Month being given, to find the Sun's Place in the Ecliptic.

Rule.—THE day of the month being given, look on the inner calendar on the horizon of the globe, and you have the ſign and degree of the ſign that the ſun is in on that day.

Ex.—I would know the ſun's place in the ecliptic, on May the 21ſt, March the 21ſt, June the 21ſt, September the 22d, and December the 21ſt.

I look for theſe days of the months in order as they ſtand in the calendar, and againſt the day of the month in the innermoſt circle of the horizon, I find the ſun's place among the ſigns.

Thus, againſt May the 21ſt, I find 1° of ♊ Gemini; and alſo on March the 21ſt, I find the ſun enters ♈ Aries; on June the 21ſt, he enters ♋ Cancer; on September the 22d, he enters ♎ Libra; and on December the 21ſt, he enters ♑ Capricorn.

Find the ſun's place in the ecliptic for the 10th of February; 13th of March; 20th of April; 14th of October; and the 9th of November.

PROB. IX.

The Sun's Place being given, to find the Day of the Month.

Rule.—THIS is only the reverſe of the former problem: for having the ſun's place given, ſeek it in the innermoſt circle among the ſigns; then againſt that degree in the calendar you have the day of the month required.

Ex.—I would know what time of the year it is when the ſun is in 1° of ♊, as alſo when he enters ♈, ♋, ♎, and ♑. Proceed according to the rule, and you will find the days to be May the 21ſt, March the 21ſt, June the 21ſt, September the 22d, and December the 21ſt.

Find what day of the month anſwers to the 10th of Taurus; the 20th of Cancer; the 15th of Leo; the 9th of Scorpio; the 25th of Sagittarius; and the 26th of Piſces.

PROB. X.

The Latitude and Day of the Month being given, to find the Sun's Place in the Ecliptic, and rectify the Globe for Uſe.

Rule.—FIND the ſun's place on the horizon by Prob. VIII. and having noted what degree he is in, look upon the ecliptic on the globe, and find the ſame ſign and degree as you did on the horizon, then bring this degree of the ecliptic very carefully to the graduated edge of the brazen meridian, and holding the globe ſteady, turn the index exactly to the upper twelve, which repreſents twelve at noon, and thus is the globe rectified for that day, and the degree of the ecliptic that lies under the meridian, repreſents the ſun's place at noon, or twelve o'clock that day.*

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* The aſtronomical day is reckoned from, or begins at twelve o'clock at noon; and, if you fix the quadrant of altitude to the latitude in the zenith, the globe will be completely rectified; but more of this hereafter.

PROB. XI.

To find the Declination of the Sun on any Day of the Year.

DEF.—THE declination of the ſun is his variation from the equator, either northward or ſouthward.*

RULE.—Having found the ſun's place in the ecliptic for the given day, bring it to the brazen meridian, and obſerve what degree of the meridian it lies under, and whether it be on the N. or on the S. ſide of the equator, for that is the declination required, which is called N. or S. declination accordingly.

Ex.—Proceed according to the rule, and you will find, on April the 21ſt, the ſun has 12° 00′ N. declination, and on May the 21ſt he has 20° 30′ N. declination; but on October the 27th, he has 12° 50′ S. declination, and on January the 30th, he has 18° S. declination nearly.

What is the ſun's declination on the firſt of January; 10th of March; 25th of June; the 28th of Auguſt; and the 29th of November?

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[*] His greateſt declination northward is 23° 30′, which is on June the 21ſt, and his greateſt declination ſouthward is 23° 30′ December the 21ſt; but on March the 21ſt, and September the 22d, when he enters ♈ and ♎, he has no declination at all, but is in the equator itſelf; and then the days and nights are equal to all the inhabitants on the globe.

PROB. XII.

The Latitude and Day of the Month being given, to tell the Sun's Meridian Altitude, viz. his Height at Noon.

Rule.—BRING the ſun's place to the meridian, and obſerve what degree of it the ſun's place is under; for thoſe degrees on the meridian that are intercepted, or lie between the ſouthern edge of the horizon, and the degree which is over the ſun's place on the meridian, is the meridian altitude required.*

Ex.—I would know in the latitude 51° 30′ on May the 21ſt, the ſun's meridian altitude, as alſo his meridian altitude on November the 5th. I proceed according to the rule, and find his meridian altitude, May the 21ſt, to be 59°; but on November the 5th, he has but 23° altitude.

Proceed thus, and you will find his meridian altitude, in the latitude of 40° on the ſame days to be 70° and 34°; but in the latitude of 20° on May 21, he will have 90° of altitude, or be directly over head that day to the inhabitants in that latitude, which ſhall be further explained.

What is the ſun's meridian altitude at Peterſburgh, Naples, Cherſon, and Syracuſe, on the 20th of December, the 10th of April, and the 21ſt of September?

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* *Note.*—The ſun's declination, when north, added to the complement of the latitude, will give the meridian altitude;—but when ſouth, ſubtract it therefrom, and the remainder will be the meridian altitude.

14 Pro— in Manuscript.

PROB. XIII.

The Latitude of the Place (ſuppoſe London) and Sun's Meridian Altitude being given, to tell the Day of the Month, ſuppoſing it were unknown.

Rule.—THIS problem is the reverſe of the laſt; for you are only to ſet the globe to the latitude, then count from the ſouthern edge of the horizon, as many degrees on the meridian upward as the given height is; then turn the globe till ſome point of the ecliptic comes under that degree of the meridian, which will be the ſun's place on that day, which ſeek in the circle of ſigns on the horizon, and againſt it is the day required.

Ex.—In the latitude of 51° 30′, on two certain days, I obſerved the ſun's meridian altitude to be 59° and 23° 30′; I demand what days they are?

Proceed according to the rule, you will find the one to be May 21, or July 24; the other November 3, or February 8. For it is to be obſerved, that the anſwer will be returned differently, according as you uſe the aſcending or deſcending ſigns; for every degree of the ecliptic has another correſponding to it in altitude, except the two tropical points of Cancer and Capricorn.

PROB. XIV.

The Latitude and Day of the Month being given, to tell the Sun's Altitude at any Time.

Ex.—ON May the 21ſt, at nine in the morning, and at five in the afternoon at London, I would know the ſun's altitude.

Rule.—Rectify the globe for the latitude, and bring the ſun's place to the meridian, and ſet the index to the upper twelve on the dial plate; then fix the quadrant of altitude in the zenith; (viz. the left edge of the nut muſt be fixed on the meridian at 51° 30′) turn the globe till the index points to the hour, viz. nine in the morning. Laſtly, turn the quadrant about, till the graduated or figured edge touch the ſun's place (viz. 1° ♊), and the degrees on the quadrant, counted from the horizon upward on the quadrant, is his height at that time; which is 43° 30′. Then turn the globe till the index points to five in the afternoon, and turn alſo the quadrant to the W. ſide (without unſcrewing it) till it touches the ſun's place, and you have about 24° on the quadrant, his altitude at that time.

But at North Cape (viz. N. latitude 72°) at nine in the morning May 21, he will be but about 32° high.

What is the ſun's altitude at ten in the morning, and three in the afternoon, at Liſbon and Stockholm?

PROB. XV.

The Latitude (ſuppoſe LONDON*), and the Sun's Altitude and Day of the Month being given, to tell the Hour.*

THIS is the reverſe of the laſt problem, and it will admit of two anſwers; for the hour may be either in the morning or afternoon.

RULE.—Rectify the globe as before directed, and turn the globe and the quadrant on the E. ſide, till the quadrant touches the ſun's place at the given height (which by the laſt, on May 21, at nine in the morning, was found 43° 30′), then look at the index, and it will point to the hour: turn it W. till the ſun's place touch the ſame degree on the quadrant on the W. ſide, and you will have the time in the afternoon.

Ex.—Thus on May the 21ſt, at London, when the ſun is 43° 30′ high, it is either nine in the morning, or three in the afternoon.

What o'clock is it at Vienna on the 9th of October, when the ſun is 18° above the horizon?

Note.—When the ſun's place and quadrant are on the E. ſide of the meridian, it is morning hours; but when the ſun's place is on the W. part of the meridian, or weſtward of it, it is afternoon.

this I do by Rt and
Oblique Ascension

PROB. XVI.

The Latitude being given, to tell the riſing and ſetting of the Sun, and the Length of the Day and Night, at any Time of the Year.

Rule.—RECTIFY the globe (that is, elevate it for the latitude, bring the ſun's place to the meridian, and index to the upper twelve), then turn it till the ſun's place comes even with or lies againſt the inner edge on the E. ſide of the horizon, then the index will ſhew you the time of the ſun's riſing; turn it to the W. ſide of the horizon, and the index will ſhew you the ſetting. Or the latter part of the problem may be ſolved thus:—having found the hour the ſun riſes, count how many it wants of twelve; for ſo many hours will it ſet after twelve. Thus, if the index points to four in the morning at riſing, it will of courſe ſet at eight at night; if it points any day at half an hour paſt ſeven at riſing, it will ſet at half an hour paſt four; both being four hours and a half from twelve at noon.

Ex.—Proceed thus, and you will find the ſun, on May 26, at London, to riſe about four in the morning, and ſet at eight at night. Now double what he wants of twelve at riſing, viz. eight hours, and it gives the length of that day at London, viz. ſixteen hours.

But at Madrid, on the ſame day, he riſes about three quarters paſt four, and ſets a quarter paſt ſeven at night. And at Stockholm, on the ſame day, he riſes at about a quarter paſt three, and conſequently the days are ſeventeen hours and a half long there.

What is the length of the day and night at Madrid, and Moſcow, on the 12th of February, and 25th of October?

Note.—If you double the number of hours between ſun riſing and twelve, it will give you the length of the day from ſun riſing to ſetting.

Note 2.—If you ſubtract the length of the day from ſun-riſing to ſun-ſetting, from twenty-four, the remainder ſhews you the length of the night, twilight included.—See Prob. XXV.

PROB. XVII.

To tell the Length of the longeſt and ſhorteſt Day at LONDON, *Latitude* N. 51° 30′, *and at* STOCKHOLM, *Latitude* N. 59° 20′.

Ex.—YOU proceed the ſame way in this as in the laſt problem, only inſtead of bringing 6° of ♊, as before, you now work with 1° of ♋, or rather 30° of ♊, for in this the ſun enters on June 21ſt, or the longeſt day.

You will find him, therefore, riſe at London June the 21ſt, at 48 m. paſt three in the morning, which wants 8 h. 12 m. of 12; this doubled gives 16 h. 24 m. for the longeſt day at London.

Then work with 1° of Capricorn, or rather 30° of Sagittarius, for the ſhorteſt day, viz. bring 30° of Sagittarius to the meridian, and the index to 12, and you will find the ſun riſes at 12 m. paſt 8, which wants 3 h. 48 m. of 12; this doubled gives 7 h. 36 m. the length of the ſhorteſt day.*

Proceed now for Stockholm (viz. 59° 20′ N. latitude), and if you work in the ſame manner, you will find the longeſt day to be about $18\frac{1}{2}$ h. and the ſhorteſt $5\frac{1}{2}$ h. And thus, for any other latitude or place, not exceeding 66° 30′; for there the days will be 24 h. and, if you go to a greater latitude, either N. or S. you will find them 30 h. long, or even 2, 3, 4, or 5 days, nay 2, 3, 4, or 5 weeks, or as many months, which I ſhall explain in a problem by itſelf hereafter.

Find the length of the longeſt and ſhorteſt days at Abo, Tornea, Warſaw, Belgrade, and Gibraltar.

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* The length of days given above, is excluſive of refraction; for if that be taken into the account, the longeſt day will be 16 h. 34 m. and the ſhorteſt 7 h. 44 m. but this would not correſpond with the operations of a globe.

PROB. XVIII.

To tell the Sun's Right Aſcenſion.

WHAT right Aſcenſion is, you will find in Dial. VII. Sect. I. Art. VIII.

Rule.—Bring the ſun's place to the brazen meridian, and note what degree of the equator is cut by the meridian, for that is his right aſcenſion required.

Ex.—I would know the ſun's right aſcenſion on March the 21ſt, June the 21ſt, September the 22d, and December the 21ſt.

I find the ſun's place for theſe different days, and bringing it to the meridian, I find the meridian cuts the equator in (0)* in (90) in (180) and in (270°) his right aſcenſion required.

What is the ſun's right aſcenſion on the 24th of February, 27th of June, 6th of December, and the 24th of January?

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* When the ſun enters ♈, March the 21ſt, he has no right aſcenſion, becauſe it is counted from, or begins at ♈; therefore, on March the 20th, he muſt have his greateſt right aſcenſion, viz. 360°.

PROB. XIX.

To find the Sun's oblique Aſcenſion and Deſcenſion at any Time, and in any Latitude.

See Oblique Aſcenſion and Declenſion, Dial. VII. Sect. I. Article 9, 10.

Rule.—RECTIFY the globe, and bring the ſun's place down to the eaſtern edge of the horizon; then obſerve in what degree the horizon cuts the equator or equinoctial, for that is the oblique aſcenſion required.

2. Turn the globe till the ſun's place comes to or lies level with the weſtern edge of the horizon,

and the degree of the equator cut by the horizon is the oblique deſcenſion required.

Ex.—Thus on March the 21ſt, June the 21ſt, September the 22d, and December the 21ſt, viz. when the ſun enters ♈, ♋, ♎, and ♑, you will find his oblique *aſcenſion* at London to be (0) (56) (180) and (304).

And on the ſame day his oblique *deſcenſion* will be (0) (123) (180) and (237½).

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* Though the latitude is not required in finding the right aſcenſion, becauſe the EQUATOR will be cut in the ſame place by the meridian, whether the pole be elevated or depreſſed; yet in the oblique aſcenſion, the HORIZON will cut the equator in different degrees, according to the latitude, as appears from working the problem.

PROB. XX.

this and the two before - like my [illegible]

The Latitude and Day of the Month being given, to tell the Sun's aſcenſional Difference, viz. how much he riſes and ſets before and after ſix; and, conſequently, to tell the Length of the Days, ſuppoſing there were no Index to the Globe.

RULE.—BY Prob. XVIII. and XIX. find the ſun's right and oblique aſcenſion; then ſubtract the oblique from the right aſcenſion, or the contrary, and the remainder is the aſcenſional difference required, which divide by fifteen, the degrees of the equator that paſs through the meridian in one hour, and the quotient gives the anſwer in time that the ſun riſes and ſets before and after ſix. See an example in figures, how to convert degrees and minutes into time, Prob. XXVII.

Ex.——For London.—On May the 26th, I find the ſun is 6° of ♊, and his right aſcenſion 64°, and on the ſame day his oblique aſcenſion is 34°; now 34° from 64° there remains 30°, his aſcenſional difference; which divide by fifteen, and the quotient gives two hours, the time that he riſes before, and ſets after ſix.

This you may prove by Prob. XVI. for you will find he riſes at four, and ſets at eight, May the 26th.

But on December the 6th, his right aſcenſion is 250°, and his oblique aſcenſion is 286°, their difference is 32°, which is two hours and eight minutes* that he riſes after, or ſets before ſix.

N. B. The right exceeds the oblique aſcenſion from ♈ to ♎, when the ſun riſes before ſix; but the other half year that he riſes after, or ſets before ſix, the oblique exceeds the right aſcenſion.

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* Each degree on the globe anſwers to four minutes of time.

PROB. XXI.

The Latitude and Day of the Month being given, to find the Sun's Amplitude, viz. his Diſtance from the E. or W. Point at his riſing or ſetting, and the Point of the Compaſs he riſes and ſets upon.

Rule.—THE globe being rectified, bring the ſun's place to the eaſtern edge of the horizon (which ſhews his riſing), then the degrees upon the innermoſt circle of the horizon, counted from the E. point to the place which the ſun's place lies againſt on the horizon, ſhew you the ſun's amplitude.

Ex.—At London.—Proceed according to the rule, and you will find the ſun's amplitude (May the 21ſt) at riſing to be about 34° from the E. to the N. and the point he riſes upon is N. E. by E. and he ſets N. W. by W. But on November the 5th, he has about 25° amplitude from the E. to the S. and at ſetting 25° from the W. to the S.—The point he riſes upon is E. S. E. and the point he ſets upon is W. S. W.

What is the ſun's amplitude at Jamaica on the 10th of May and 2d of February?

PROB. XXII.

Like the Meaning

The Latitude, Day, and Hour being given, to find the Sun's Azimuth, viz. his Diſtance from the E./O. *and* W. *or from the* N. *and* S. *Points at any Time.*

Rule.——RECTIFY the globe, then turn it round till the index points to the given hour; this being done, turn the quadrant, till it touches the ſun's place for the given day; and then the quadrant will cut the horizon in the azimuth required from the E. or W. points, or from the N. or S. points, for you may reckon from either, only then name it properly and accordingly.

Ex.—For London.—Thus on Auguſt the 17th, at nine in the morning, the ſun will have about

30° azimuth from the E. to the S. or, which is the ſame, 60° from the S. to the E. for 60° and 30° make 90°, the whole quadrant from E. to S.*

This will appear yet plainer, if we would know the azimuth of the ſun the ſame day, at eleven in the morning, which is about 68° from the E. to the S. or 22° from the S. to the E.

But on May the 21ſt, at three in the afternoon, he will have 22° azimuth from the W. to the S. viz. 68° azimuth from the S. to the W. And at three quarters paſt five, his azimuth is about 10° from the W. to the N. or 80° from the N. to the W.

TYRO. Sir, I underſtand the examples very well; but how am I to expreſs or name the azimuth in general?

PHILO. By the words North and South, becauſe it will always be either northward or ſouthward, reckoning from the E. and W. points, either North or South.

Thus as before, Auguſt the 17th, at nine in the morning, the ſun has 30° S. azimuth (viz. from the E. point ſouthward) but on May the 21ſt, at ½ h. paſt four in the morning, he has 30° N. azimuth, viz. 30° from the E. northward.

Tell me what the azimuth of the ſun will be at Medina on the 4th of June, at eight in the morning, and two in the afternoon? And again at Samarcand on the 15th of November, at nine in the morning and one in the afternoon?

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* Some authors call this 60° S. amplitude; but others call it 30° S. amplitude; that is, 30° from the E. to the S, as I ſaid before.

Manu-script
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PROB. XXIII.

The Latitude and Azimuth being given on any Day, to tell the Hour or Time of the Day.

Rule.—THIS is the reverſe of the former problem, for the globe being rectified, turn the quadrant of altitude to the given degree of azimuth (from the E. or W. point on the horizon), and there hold the quadrant ſteady with one hand, and with the other turn the globe, till the ſun's place for the given day touches the figured edge of the quadrant, and the index will point to the hour or time required.

Ex. for London.—On Auguſt the 17th, I obſerved the ſun's azimuth to be 30° from the E. to the S. I would know the hour. Anſwer, nine in the morning.

Again, on May the 21ſt, I find his azimuth 10° from the W. to the N. what is the hour? Anſwer, three quarters paſt five in the afternoon.

PROB. XXIV.

The Latitude, Day, and Hour, being given, to tell the Sun's Almacanther.

Def.—ALMACANTHERS are circles of altitude parallel to the horizon, whoſe poles are the zenith and nadir; ſo that you may imagine as many circles of altitude or almacanthers as you pleaſe.

Rule.—The almacanther is found the ſame way as the altitude of the ſun at any time; therefore, I refer you back to Prob. XIV.

PROB. XXV.

The Latitude and Day being given, to tell what other Day of the Year will be of the ſame Length.

Rule.—HAVING found the ſun's place for the given day, bring it to the meridian, and obſerve its declination; then turn the globe till ſome other degree of the ecliptic comes to the ſame degree of declination under the meridian; this being done, ſee what day of the month anſwers to the ſun's place then under the meridian, for that is the day required; which you may eaſily prove by Prob. XVI.

Ex.—I would know what day is of the ſame length as May the 26th, and of the ſame length as April the 17th. Anſwer, July the 16th, and Auguſt the 24th.

What days are of the ſame length as the 24th of February and the 9th of October?

Note.—Theſe laſt eight Problems, as alſo Prob. VIII. IX. and X. are common to both globes; but are inſerted here, becauſe many perſons have a terreſtrial, that have not a celeſtial globe. But the following problems more particularly belong to the terreſtrial globe.

PROB. XXVI.

The Latitude and Day of the Month being given, to tell the Beginning, Ending, and (conſequently) the Length, or Continuance, of Twilight.

DEF.—TWILIGHT is that faint light which begins immediately after the ſun ſets in the evening, and continues till he is 18° below the horizon; and begins in the morning, when the ſun comes within 18° of the horizon on the E. ſide, and ends when he riſes.

TYRO. I have heard that this problem is very difficult in compariſon of ſome others.

PHILO. It is ſomething longer in its operation, but very eaſy, if you mind the rule and the operation together.

RULE.—The globe being rectified, if the quadrant of altitude do not extend below the horizon, bring the degree directly *oppoſite* to the ſun's place to the quadrant of altitude, ſo that it touches juſt 18° on the quadrant, then it is plain that the ſun's real place will be depreſſed 18° below the horizon; look on the index of the horary circle, which will point (if among the morning hours) to the beginning, or (if among the evening hours) to the ending of twilight.*

But if the quadrant extend to 18° below the horizon, which in all modern globes is the caſe, then rectify as before, for latitude, zenith, and ſun's place, and turn the globe till the ſun's place is 18° below the horizon, and you have the beginning or end of twilight, according as it is on the eaſt or weſt ſide of the horizon.

Tyro. Sir, I now underſtand it very clearly.

Philo. Proceed then according to the rule, and you will find that on March the 21ſt, and September the 22d, twilight begins about 4 in the morning, and ends about 8 at night.

The ſun on theſe days, you know, riſes and ſets at 6. Add, therefore, the length of morning and evening twilight to 12 hours (the length of the days then) and it gives 16 hours; this ſubtracted from 24 hours, leaves 8 hours, the length of the real, or dark night.

So alſo on April the 24th, twilight begins about ½ paſt 2, ends about ½ paſt 9, and laſts in all 4 h. 40 m. But on December the 20th, it begins nearly at 6, and ends at 6, and laſts in all 4 h. 14 m.†

PROB. XXVII.

The Hour where you are being given, to tell what Hour it is in any other Part of the World. See Prob. VII.

Rule.—BRING the given place to the meridian, and ſet the index at the given hour; then turn the globe till the other place, or places, come under the meridian, and the index will point to the real time in the place required.

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* What I mean by the degree oppoſite to the ſun's place, is this; it is that degree of the ecliptic, oppoſite to, or 180° from the given place of the ſun. Thus, ſuppoſe the ſun were in ♈, then I bring its oppoſite ſign (viz. ♎) to 18° on the quadrant, ſo will ♈ be depreſſed 18°, and the index will ſhew the hour.

† There is no real night at London (but twilight) from May the 22d, to July the 20th, the ſun all that time being leſs than 18° below the horizon.

Ex.—When it is 2 o'clock in the afternoon at London, I would know the time at Jeruſalem, and at Port Royal, or Kingſton, in Jamaica.

Proceed according to the rule, and you will find, that when it is 2 in the afternoon at London, it is 22 minutes paſt 4 at Jeruſalem; and but 52 minutes paſt 8 in the morning at Port Royal.

Another Method.

I told you in Prob. XX. that 15° on the equator make 1 hour of time; therefore this problem may be ſolved by common diviſion, for having the difference of the longitude of any two places (taken from a map) divide it by 15, the quotient is the difference of hours; and if any degrees remain, allow 4 m. for every degree, and ſo in proportion for the odd minutes or miles.

Thus I find by Prob. VI. Jeruſalem is 35° 25′ E. long. of London; I divide, therefore, 35° 25′ by 15, and the quotient is 2 hours, and the remainder is 5° 25′, which is 5 times 4, or 20 m. and the odd 25 m. or miles, is nearly 2 m. ſo that the difference is 2 hours 22 m. nearly, and as Jeruſalem is eaſt of London, it has its hour before us, therefore it is 22 m. paſt 4 in the afternoon.

Again, Port Royal is 77° 00′ W. of London; this converted into time as before is 5 h. 8 m. that Port Royal has its time later than London; for when it is noon at London, it wants 8 m. of 7 in the morning at Port Royal.

At 10 in the morning and 3 in the afternoon at Peterſburgh, what o'clock is it at Pekin and Ferro?

PROB. XXVIII.

The Day of the Month being given, to tell thoſe Inhabitants that will have the Sun in their Zenith *on that Day.*[*]

Rule.—BRING the ſun's place to the meridian, and obſerve exactly his declination for that day; then turn the globe any way, and obſerve what places paſs under that degree of declination on the meridian; for all ſuch will have the ſun directly over their heads ſome time or other in the 24 hours.

Ex.—I would know what inhabitants, or places, will have the ſun in their zenith on May the 21ſt.

Proceed as directed by the rule, and you will find the city of Mexico, Campeachy, St. Jago in Cuba, Owhyhee, and many other places that will paſs under that degree of declination (viz. 20° N.) and will have the ſun in their zenith on that day.

Alſo on April the 16th, the inhabitants of Porto Bello, Carthagena, Cape Delgado in Africa, Iſle of Trinidad, Cochin in India, the Philippine Iſlands, and Sierra Leone (the new Engliſh ſettlement on the Weſt coaſt of Africa), will have the ſun that day in or near their zenith.

What people endure a vertical ſun on the 21ſt of March and Chriſtmas Day?

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[*] This cannot happen to any other inhabitants but thoſe in the Torrid Zone, that is, to ſuch as have not above 23° 30′ of latitude, either N. or S.

PROB. XXIX.

The Day and Hour being given in any Place, to find the Place to which the Sun is then vertical, viz. in the Zenith.

Rule.—BRING the given place to the brazen meridian, and turn the index to the given hour; this done, turn the globe till the index points to the upper 12, or noon; then look under the degree of the ſun's declination on the globe for that day, for that is the very ſpot, or place, to which the ſun is then vertical.

Ex.—On May the 10th, at 8 m. paſt 5 in the afternoon, at London, I would know what place has the ſun then in its zenith. Anſwer, Port Royal, in Jamaica.

Thus alſo will you find that, when it is 33 m. paſt 6 in the morning at London, on April the 10th, and Auguſt the 31ſt, the inhabitants at Candy, in the iſland of Ceylon, will have the ſun then in their zenith.

Where is the ſun vertical at this moment, 5 o'clock in the morning, June 21, at London?

N.B. There are two days in which the ſun is vertical to all the inhabitants of the torrid zone; which muſt be when the ſun has the ſame declination; and in this Problem the other day will be Auguſt 2; viz. the ſame declination as on May the 10th.

PROB. XXX.

*To find the Diſtance of one Place from another in Degrees and Minutes (*viz. *Miles) in an Arch of a great Circle*, alſo their Bearing, or Situation, in reſpect of each other.*

Rule.—BRING one of the places to the meridian, and elevate the globe for the latitude of it, and fix the quadrant in the zenith: then turn the globe till the quadrant touches the other place, and the degrees on the quadrant between place and place ſhew the diſtance; and the quadrant at the ſame time will cut the horizon in the point of the compaſs, called the bearing, or ſituation, from the firſt place.†

Ex.—I would know the diſtance from London to Port Royal, Jeruſalem, and Moſcow, as alſo their ſituation in reſpect of London.

Proceed according to the rule, and you will find from London

	DEG.		MILES.	
To Port Royal	72	viz. nearly	5004	~~E.~~ Westly
Dist. 2/89 To Jeruſalem	31½		2158	E. S. E.
To Moſcow	21		1460+	E. N. E.

What is the diſtance and bearing of St. Salvador, the Havannah, and the ſouthern point of California, from Madrid?

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* *Note*, 60 miles, or minutes, are reckoned a degree in general; but this is a vulgar error; for it is proved that each degree on the earth's ſurface in every great circle (ſuch as the equator, meridian, &c.) is 69½ miles; therefore, muitiply the degrees by 69½, you have the diſtance in Engliſh miles.

† The bearing is here to be underſtood on the arch of a great circle, which is by an angle of poſition, very different from a bearing by the compaſs.

+1459½

manuscript
Problem 13th

PROB. XXXI.

The Latitude and Day being given, to tell what Time the Sun will be due E. or W.

Tyro. THIS is eaſy, I think; for as the ſun is always due N. and S. at 12 at night, and at 12 at noon, I ſuppoſe he will be due E. and W. at 6 in the morning, and 6 in the evening.

Philo. I thought you would ſtumble upon this general error; but you will ſoon ſee your miſtake.

Rule.—Rectify the globe, and turn the quadrant till it touches the E. or W. point of the horizon; this done, turn the globe till the ſun's place for the given day comes to the edge of the quadrant; ſo will the index of the horary circle point to the hour of his being due E. or W. on that day.*

Proceed thus, and you will find about 5 m. paſt 7 in the morning, on May the 21ſt, at London, the ſun will be due E. and about 5 m. before 5 in the evening due W. On June the 21ſt, he will be due E. about 22 m. paſt 7 in the morning; but on December the 21ſt, he is due E. about 45 m. paſt 4 in the morning, and due W. about 15 m. paſt 7 in the evening.

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* *Note.* At the equinoxes the ſun is due E. and W. at 6 in the morning, and at the ſame hour in the evening.

PROB. XXXII.

To find the Antœci *to* London, *or any other Place.*

See Dialogue VI. Sect. IV. Article 1.

Rule.—BRING London (or the given place) to the meridian, and count from the equator on the meridian ſouthward the ſame number of degrees of S. latitude, as London has N. (viz. 51° 32′), and cloſe to the edge of the meridian make a dot, for that is the place of the Antœci to London, which is in the ſouthern ocean, about 21° S. W. of the Cape of Good Hope.

Ex.—Who are the Antœci to the people of New York? and to the inhabitants of Alexandria in Egypt?

PROB. III.

To find the Periœci *to* London, *or any other Place.*

See Dial. VI. Sect. IV. Article 2.

Rule.—BRING London to the meridian, and turn the globe till 180° of the equator paſs from London under the meridian; then under the ſame latitude as London (viz. under 51° 32′ N.) at the edge of the brazen meridian make a dot, for that is the place of the Periœci required, which is about 40° E. of Japan.

Ex.—Who are the Periœci to the people of Tunis?

PROB. XXXIV.

To find the Antipodes *to* London, *or any other Place.*

See Dial. VI. Sect. IV. Article 3.

Rule.—BRING London to the meridian, and turn the globe till 180° paſs through the meridian, then count 51° 32′ ſouthward on the meridian, and under it is part of the Pacific Ocean S. E. of New Zealand, which is the Antipodes to London.

Ex.—What are the Antipodes of the inhabitants of Manilla? Find the Antœci, the Periœci, and the Antipodes of Bencoolen in the iſland of Sumatra.

PROB. XXXV.

The Time of an Eclipſe of the Sun or Moon being given, to find all thoſe Countries, or Parts of the Globe, in which it will be viſible.

Rule 1.—FOR the Sun: Find the place to which the ſun is vertical at the time of the eclipſe, by Prob. XXIX. elevate the globe for the latitude of that place, and bring it to the zenith or top of the globe; then to all places in the upper hemiſphere, if the eclipſe be large, part of the ſun will appear viſibly obſcured; but if the eclipſe be ſmall, in places near the horizon, it will be inviſible on account of parallax.

2. For the Moon:—Find the place to which the ſun is vertical at the time of the eclipſe, as before directed; then find the Antipodes to that place, viz. the point exactly oppoſite thereto, (which will be the place of the moon at that time) bring this point to the zenith; then to all the inhabitants of the upper hemiſphere, the eclipſe will be viſible; to thoſe of the lower one inviſible.

Ex.—Sept. 5, 1793, the ſun was eclipſed at eleven in the morning;—Query, in what parts of the globe was this eclipſe viſible?

Proceed according to the rule, and you will find the ſun vertical to a part of the coaſt of Guinea, in Africa, a little north eaſt of Calabar; which point being brought to the zenith, Europe, Africa, part of Aſia, and of North and South America, will appear in the upper hemiſphere, and in each of theſe the eclipſe will be viſible, but more particularly in Africa. The ſun will be nearly vertical to Sierra Leone at the end of the eclipſe.

In the courſe of the preſent year 1809 there will happen two eclipſes of the ſun; the firſt on April 14, at about 9 at night, long after the ſun is ſet. It will therefore be found to be inviſible to Europe, Aſia, and Africa. But to the greater part of America, to the inhabitants in the iſlands of the ſouthern Pacific Ocean, it will be a large and beautiful eclipſe, and to the Marqueſas in particular, in 11° S. L. and 136° W. L. the ſun will be totally and centrally eclipſed.

On the 17th of Auguſt, at about 6 in the morning, the ſun will be eclipſed, I wiſh to know whether it is viſible to the inhabitants of Great-Britain.

Feb. 14, 1794, there was a total, and almoſt central, eclipſe of the moon, at ten o'clock at night; on what parts of the globe was it ſeen?

Proceed as before directed, and you will find the ſun vertical to a part of the South Sea, a little north of Otaheite and the Society Iſles, the oppoſite point to which (viz. the place of the moon at that time) will be found in Africa, near the ſource of the river Nile; which point being brought to the zenith, Europe, Africa, great part of Aſia, and Brazil in South America, will appear above the horizon, and in all theſe the eclipſe will be viſible.

Note, The time given in each of the foregoing examples is that of the middle of the eclipſe (it being then more extenſively conſpicuous) but to find all the places at which any eclipſe will be viſible, the ſame operation muſt be repeated for the beginning and end, finding the place where the ſun is vertical, &c. at each time.

PROB. XXXVI. Jan - 5

The longeſt Day in any Latitude being given (ſuppoſe London 16½ *Hours) to tell in what other Latitude the longeſt Day is* 1, 2, 3, *&c. Hours longer than in the given Place.*

Rule.—RECTIFY the globe for the given latitude (viz. London), and bring the ſolſtitial colure (viz. ♋) to the meridian; then where the horizon cuts the tropic of ♋ make a dot on the tropic at the edge of the horizon: this done, turn the globe weſtward, till 7° 30′ of the equator paſs under the meridian, and then make a ſecond dot on the tropic againſt the horizon as before; then turn the globe back to its firſt poſition (viz. to ♋) and elevate the pole, till the ſecond dot appears at the edge of the horizon, and the horizon will cut the meridian in the latitude required.

Proceed as above, and you will find that in the latitude of 56° 20′, the days are one hour longer than at London; and by comparing the 11th climate in the Table p. 13, with the places that go under latitude 56° 20′ you will find they agree. The truth of the thing may be proved by Problem XVII.

2. If you wiſh to know the latitude where the day is two hours longer than at London, proceed as before, only inſtead of cauſing 7° 30′ to paſs under the meridian, you muſt now turn the globe till 15° paſs under the meridian, and make then a dot on the tropic, as before.

3. If for three hours longer, make 22° 30′ paſs through the meridian, and proceed as before; and thus for every hour, cauſe 7° 30′ more to paſs under the meridian.

If you wiſh to know the latitude where the longeſt day is an hour *ſhorter* than at London, only turn the globe eaſtward, inſtead of weſtward, till 7° 30′ paſs through the meridian, and make a dot on the tropic, and depreſs the pole till this lies even with the horizon, you will find the latitude about 45° 30′. Thus for two hours longer about 60°, for four hours about 64° 30′; but for two hours ſhorter the latitude is about 36° 30′. This Problem ſhews you how to find the difference of climates.

This agrees to L
in manuscript

PROB. XXXVII.

Any Time not exceeding ſix Months being given, to tell that Latitude, or thoſe Places, in which the Sun will not ſet for all that Time.

Rule.—HERE 28 days are reckoned to the month. Bring the given time into days, and take the half of the number of days; but remember to abate 1 if the half exceeds 36. Then count from Cancer on the ecliptic the ſame number of degrees as the half amounted to, and where this reckoning ends make a dot on the ecliptic. Laſtly, bring this dot to the meridian, and as many degrees as are intercepted, or lie between the dot and the pole itſelf, counted on the meridian, is the latitude required.

Ex.—I demand the place, or latitude, where the ſun does not ſet for the ſpace of 4 months and 16 days.

This is 128 days, the half is 64°, abate 1° and it is 63°; this I count from ♋ on the ecliptic, and make a dot, and bringing it to the meridian, I find there are nearly 80° between the dot and the pole; viz. the latitude is 80°, which is the upper part of Greenland.

So alſo in the latitude of 85°, he does not ſet for 5 months and 2 weeks. And in the latitude of 86° 30′ not for 5 months, 3 weeks, and 3 days; and in the latitude of 90°, not for 6 months; viz. from March the 21ſt to September the 22d.

Tyro. This appears, now, very plain to me, but I know the generality of perſons believe it to be falſe, for want of conſideration.

Philo. You ſee it is evident, for under the pole, in the latitude of 90°, when the ſun enters ♈ he begins to riſe, and does not ſet with the inhabitants there (if there be any) till he enters ♎; viz. for 6 months.

Tyro. I ſee it, Sir, very clearly; but, pray, have they not alſo a great ſhare of twilight? And are not the inhabitants at the contrary pole in darkneſs for a long time?

Philo. Yes, and ſo are the inhabitants in the N. part, when the ſun is in the tropic of ♑. This is plainly demonſtrated by the next problem.

Problem No: 2 & 3. in manuscript

PROB. XXXVIII.

To tell in the Latitude 90 (where the longeſt Day is ſix Months) how long it continues to be Twilight after Sun-ſet; and how long their Night is after Twilight ends, before it begins again.

Rule.—YOU remember, according to the laſt Problem, that the ſun ſets with the inhabitants at the N. pole, and riſes to thoſe of the S. pole, on September the 22d; conſequently twilight begins with thoſe at the N. pole on September the 22d. Therefore,

1. Elevate the N. pole to the zenith, and turn the globe, till ſome degree of the ſun's place in

the ecliptic lies under 18° of the meridian, on the S. ſide of the horizon, and you will find it 22° ♏, viz. November the 14th, the ending of twilight, that is, they have twilight from September the 22d, to November the 14th, and then they begin to have dark night (ſave the advantage of the moon) till the 28th of January. For,

2. Turn the globe till ſome other point of the ecliptic comes under 18° as before, and you will find it about 8° of ♒, which anſwers to the 28th of January, the beginning of twilight to the inhabitants of the N. pole, and on March the 21ſt, the ſun riſes with them.

Thus it appears, that the length of their day (from ſun-riſing to ſun-ſetting) is from March the 21ſt, to September the 22d, viz. 185 days.* The length, or continuance, of twilight, is from September the 22d, to November the 14th, and from January the 28th, to March the 21ſt, in all about 105 days; and their real night is from November the 14th, to January the 28th, viz. about 75 days.

The ſame holds good as to the inhabitants of the S. pole; for the ſun riſes with them when he enters ♎, and ſets with them when he comes to ♈.

Tyro. I perceive it plainly, Sir, and thank you for this clear demonſtration.

Philo. Now, Tyro, I ſhall ſhew you the uſe of the celeſtial globe; and after that give you ſome Problems, for the practical uſe of both globes.

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* It is an eſtabliſhed maxim with many geographers, that all parts of the globe equally enjoy the benefit of the ſun, in reſpect of time, and are equally deprived of it; but from hence it evidently appears that the North Pole is five of our days every year, longer in the illuminated hemiſphere than the South Pole.

PROB. XXXIX.

The Day of the Month being given, to find on the celeſtial globe the Sun's Place in the Ecliptic.

See Problem VIII.

PROB. XL.

This is the reverſe of the laſt, and done the ſame way as Prob. IX.

PROB. XLI.

To find the Declination of the Sun on any Day of the Year.

The ſame as Prob. XI.

PROB. XLII.

To find the Sun's right Aſcenſion.

See Prob. XVIII.

PROB. XLIII.

To tell the Sun's oblique Aſcenſion and Deſcenſion in any Latitude, and on any Day.

The ſame as Prob. XIX.

PROB. XLIV.

The Latitude and Day being given, to find the Sun's aſcenſional Difference.

The ſame as Prob. XX.

PROB. XLV.

The Latitude and Day of the Month being given, to tell the Sun's Amplitude, viz. his Diſtance from the E. *and* W. *Points at riſing and ſetting.*

The ſame as Prob. XXI.

PROB. XLVI.

The Latitude and Day being given, to tell the Sun's Azimuth.

The ſame as Prob. XXII.

PROB. XLVII.

The Latitude, Azimuth, and Day being given, to tell the Hour of the Day.

See the Rule, Prob. XXIII.

PROB. XLVIII.

The Latitude, Day, and Hour being given, to tell the Sun's Almacanther.

See the Rule, Prob. XXIV.

PROB. XLIX.

To find the Right Aſcenſion of any Star.

Rule.—BRING the ſtar to the meridian, and the degree of the equinoctial, cut by the meridian, is the right aſcenſion required.

Ex.—Thus you will find the right aſcenſion of Aldebaran in Taurus to be about 66°; Arcturus in Bootes about 211° 34′; Rigel in Orion about 76° 8′; and Sirius, or the dog-ſtar, about 99°, &c. &c.

What is the right aſcenſion of Dubhe in he Great Bear, Lyra, and Capella?

PROB. L.

The Latitude of the Place being given, to tell the oblique Aſcenſion and Deſcenſion of any Star.

Rule.—RECTIFY the globe for the latitude of the place, and bring the ſtar to the eaſtern edge of the horizon, and the degree of the equinoctial, that is then cut by the horizon, is the oblique aſcenſion required. Turn the ſtar to the weſtern ſide, and the degree of the equinoctial, cut by the horizon at the ſetting of the ſtar, is the oblique deſcenſion required.

Ex.—Proceed thus, and you will find the oblique aſcenſion of Rigel to be about 86° 56′;—of Markab in Pegaſus, about 325° 13′; and of Aldebaran, or the bull's eye, about 44° 45′. Turn each of theſe to the weſtern ſide, you will find their oblique deſcenſion 65° 22′; 2° nearly; and 87° 15′.

What are the oblique aſcenſion and deſcenſion of Cor-Hydræ, Sirius, and Atair in the Eagle?

Note.—There is this difference between the right and oblique aſcenſion and deſcenſion of the ſun and ſtars, that the ſun's oblique aſcenſion, &c. differs every day in the ſame latitude; but the ſtars oblique aſcenſion is every day the ſame.

PROB. LI.

To tell the Declination of the Stars.

Rule.—AS for the ſun's place, ſo alſo here, bring the given ſtar to the brazen meridian, and obſerve what degree of the meridian lies directly over the ſtar, for that is the declination either N. or S. according to which ſide of the equinoctial it lies on.

Ex.—Thus you will find the declination of Aldebaran to be about 16° 5′ N. The upper pointer to the pole (in Urſa Major) about 62°+18′, and the lower one 56° 55′, but Regel in Orion I find about 9° S. and Antares or Cor Scorpionis about 26° S. declination.

+56

What is the declination of Markab; Formahaut in the S. Fiſhes mouth, and Bellatrix in Orion?

From this Problem and the XLIXth ariſeth

PROB. LII.

The Right Aſcenſion and Declination of any Star being given, to find the Star at once.

Rule.—BRING the given degree of right aſcenſion on the equinoctial to the brazen meridian, then look under the degree of declination on the meridian, and there you will find the ſtar.

Ex.—Thus, ſuppoſe I wanted to find Aldebaran, whoſe right aſcenſion is 66°, and his declination 16° 5′ N. I firſt bring 66° of the equinoctial to the meridian; and looking under 16° 5′ N. declination on the meridian, I find Aldebaran.

So alſo Sirius has 99° right aſcenſion, and 16 26′ S. declination; therefore I bring 99° of the equinoctial to the meridian, and looking under 16° 26′ S. declination of the meridian, I find Sirius juſt at the meridian. The ſame for any other ſtar.

PROB. LIII.

To tell the riſing and ſetting of the Stars, and the Point of the Compaſs any Star riſes or ſets upon in any Latitude, and on any Day of the Year.

Rule.—BRING the ſun's place to the meridian, and rectify the globe; then turn the globe till the given ſtar comes to the eaſtern verge of the horizon, and the index of the hour circle will point to the time of riſing, and the horizon will ſhew the point it riſes upon: turn it to the Weſt, and the index will point to the time of ſetting, and the horizon will ſhew you the point it ſets upon.

Ex.—Proceed thus, and you will find that Aldebaran, on November the 5th, at London, riſes a little paſt ſix in the evening, and ſets about nine in the morning. The point he riſes upon is E. N. E. and the point he ſets upon is W. N. W. But Rigel in Orion, the ſame night, riſes a little before nine at night, and ſets about half paſt ſeven in the morning. The point of riſing is E. by S. and of ſetting W. by S.

When do Regulus and Arcturus riſe to the inhabitants of Liſbon on the 1ſt of June, and on the 10th of January?

Note.—The ſtars riſe and ſet every day on the ſame point of the compaſs, though at different hours.

PROB. LIV.

To tell the Time, viz. how many Hours any Star continues above the Horizon, from its riſing to its ſetting, in any Latitude.

Rule.—RECTIFY the globe, then bring the ſtar to the eaſtern verge, and note the time of riſing; then turn the globe to the weſtern ſide, and the number of hours that the index paſſes over on the dial plate tells you the continuance of that ſtar above the horizon.

Ex.—Thus, I find Aldebaran at London continues up from the time of his riſing on any day (but for example take December the 25th) about fifteen hours, and Regel about ten hours and a half.

At Stockholm Aldebaran continues up above ſixteen hours; but at Port Royal he continues up only about twelve hours and three quarters.

PROB. LV.

To tell the Diſtance of one Star from another, in Degrees and Minutes, in the Arch of a great Circle.

THIS Problem properly contains four queſtions, and therefore requires four anſwers.

1. If the ſtars lie under the ſame meridian, but have different declinations, bring them to the brazen meridian, and the degrees intercepted between them, counted on the meridian, is the diſtance required.

Thus, I find, the two pointers in the Great Bear to be about 5° 30′ diſtant from each other; and Deneb in the Stork, and the Dolphin's eye about 29° 30′ diſtant.

2. If they have the ſame declination, but be under different meridians, bring the firſt (at pleaſure) to the brazen meridian, and note the degree cut by the equator; then bring the other to the meridian, and note how many degrees have paſſed through the meridian, for theſe ſhew their diſtance required.

Thus, I find, the difference between Lyra and Caput Meduſæ to be about 122° 30′; for Lyra (38½ declination) being brought to the meridian, cuts the equator in 277° 30′, viz. 82° 30′ from ♈ weſtward; and Caput Meduſæ cuts 40° of the equator eaſtward; their diſtance, therefore, is 122° 30′.

3. If the ſtars neither lie under the ſame meridian, nor have the ſame declination, then bring either of them to the meridian, and elevate the

pole to the ſame height as the ſtar has declination, (that is, the ſame as you elevate the terreſtrial globe to the latitude of a place), for then the ſtar will be in the zenith: then fix the quadrant to the zenith, over the given ſtar, and extend it to the other ſtar, and the degrees on the quadrant ſhew the diſtance required in a true arch of a great circle.

Thus, I find the diſtance between Capella and Cor Hydræ to be about 79°, and between Aldebaran and Sirius about 46° 30′, &c.

4. If the ſtars be at ſuch a diſtance from each other that the quadrant will not reach them, then bring either of them to the horizon, and elevate or depreſs the pole, till the other lies alſo at the verge of the horizon, and the degrees counted upon the horizon, between ſtar and ſtar, is their diſtance in degrees.

Thus, between Aldebaran and Cor Scorpionis, you will find about 170 degrees.

Note.—Though the diſtance of the ſtars from each other is thus determined by degrees, yet you are not to ſuppoſe their diſtance is ſo many degrees to be converted into Engliſh miles, but it only means, that they appear under ſuch angle, that is, between Capella and Cor Hydræ is an angle of 70°.

PROB. LVI.

To tell what Stars will be on or near the Meridian, at Noon and at Midnight.

FIRST, FOR THOSE AT NOON.

RULE.—BRING the ſun's place to the meridian for the given day, and all thoſe ſtars that are then under the meridian are the ſtars required.

Ex.—Thus, I find, on ~~May~~ the 27th, Aldebaran is on the meridian at noon, and Cor Hydræ will be on the meridian Auguſt the 7th at noon; but on February the 4th, Cor Hydræ will be full S. about midnight. For only turn Cor Hydræ under the meridian, and the index will point to the lower 12; and the meridian itſelf will cut the ecliptic in ~~60~~° of ♒, viz. February the 4th.
16

PROB. LVII.

The Latitude, Day of the Month, and Hour of the Night, being given, to find the Altitude and Azimuth of a given Star.

Rule.—RECTIFY the globe for the latitude, and day of the month, then ſet the hour index to the given hour, and move the quadrant of altitude to the given ſtar; its azimuth will then appear on the horizon, and its altitude on the edge of the quadrant.

Ex.—Thus, at London, the 11th of May, at eleven o'clock at night, I find the altitude of *Cor Leonis* to be 26° 50′, and its azimuth 76° 30′ from the South towards the Weſt, or nearly Weſt by South.

What will the altitude and azimuth of Arcturus be on the 20th of September, at two o'clock, in the latitude of Liſbon?

PROB. LVIII.

The Latitude, Day of the Month, and Altitude of a Star, being given, to find the Hour of the Night.

Rule.—RECTIFY the globe for the given latitude, and day of the month, then turn the globe about in ſuch a manner that the ſtar may be upon the edge of the quadrant in the given degree of altitude, then will the index point to the hour of the night.

This is the converſe of the former Problem, and therefore needs no example.

PROB. LIX.

To tell what Stars never riſe, and thoſe that never ſet, at London.

Rule.—1. ONLY obſerve what ſtars have above 38° 30′ N. declination; for all ſuch never ſet at London, but are always above the horizon.

2. Obſerve alſo thoſe ſtars that have above 38° 30′ S. declination, for thoſe never riſe, but are always under the horizon at London.

Ex.—Thus the pointers in the Great Bear, Deneb in Cygnus, and many others, never ſet.

Alſo, Canobus in Argo Navis, and Pes Centauri, and many others, never riſe at London.

Tyro. Sir, you have highly obliged me, and I ſee now very plainly the different aſpect of the heavens in different places.

PHILO. From what you have been taught, *Tyro*, it is eaſy to conceive, that by the inhabitants under the North Pole no South ſtar can ever be ſeen, nor can the inhabitants at the South Pole ever ſee one of the ſtars in the other hemiſphere; but the inhabitants under the equator have a pleaſant ſight of all the ſtars from pole to pole, for they riſe and ſet with them at right angles; therefore no ſtar can continue above twelve hours above their horizon.

PROB. LX.

To know at any Time of the Year (in the Latitude of London) where to find any Star, or tell the Name of any Star when required.

RULE.—RECTIFY the globe for the day, and turn it till the index points to the given hour, then by a quadrant take the height of the required ſtar; or, for want of it (in a common way of gueſſing) obſerve what part of the heavens it is in, viz. whether E. N. S. W. or the like, as alſo its height as near as you can gueſs: this being done, ſet the globe in due order for the day and hour, and you will find the ſame ſtar on the globe; and, by applying the quadrant, you will find the exact point of the compaſs, and the real height the ſtar then has, which, though not perhaps near to what you gueſſed them at, yet, if it be any noted ſtar, you may aſſure yourſelf are its real height and bearing, as there is no other ſtar of note near it about that height, and upon the ſame point.

Ex.—Walking on December 25, at eight at night, I obſerved a bright ſtar (as near as I could gueſs) on the S. E. point, and about 48° high; I would know what ſtar it is. Anſwer, Aldebaran. I rectify the globe, and turn the index to the hour, and then turn the quadrant to the given point of the compaſs, and looking about 48° high on the quadrant, I find Aldebaran to be the neareſt bright ſtar by the quadrant on that point and at that height; therefore I conclude it is Aldebaran.

Alſo at three quarters paſt ten the ſame night, I ſee two very bright ſtars, one on, or near the meridian, about 30° high, and the other near the S. E. point, and about 35° high. I demand their names. Anſwer, Rigel in Orion's foot, and Procyon on Canicula.

PROB. LXI.

To tell the Latitude and Longitude of the Stars.

Rule.—FIRST, obſerve whether the given ſtar be on the N. or S. ſide of the ecliptic; and if it be on the N. ſide, elevate the N. pole 66° 30′, and turn the globe till ♋ and ♑ lie in the N. and S. points of the horizon, that is, till the ecliptic be parallel or even with the horizon; fix the quadrant in the zenith; then, keeping the globe ſteady, turn the quadrant till the edge of it touches the centre of the ſtar, and that degree on the quadrant (viz. the altitude of the ſtar in the latitude 66° 30′) is the latitude required, and the degree of the ecliptic, cut by the quadrant, reckoned from Aries (or rather reckoned among the ſigns, as it happens) is the longitude required.

Thus you will find Arcturus in Bootes to be about 30° 57′ N. latitude, and 210° longitude from ♈, or rather 32° of ♎. Alſo Athair is about 29° N. latitude, and 25° of longitude in ♑.

2. *For any* SOUTH STAR.

Elevate the S. pole 66° 30′, and fix the quadrant in the zenith, and apply it to the ſtar, as before directed, you have the latitude and longitude required. Thus you will find Pes Centauri to be about 42° 28′ of S. latitude, and 237° longitude from ♈, or rather 27° in ♏, and thus for any other ſtar.

PROB. LXII.

The Latitude and Day of the Month being given (ſuppoſe December 25, *at Nine at Night at* LONDON*), to ſet the Globe ſo as to repreſent the Face of the Heavens at that Time, and ſhew the Names and Poſitions of the moſt eminent fixed Stars.*

RULE.—RECTIFY the globe for the latitude, and bring the ſun's place to the meridian, and the index to twelve. Then turn the globe to the given hour, viz. nine at night, and there fix it, ſo will every ſtar on the globe (if you ſet the globe N. and S.) correſpond with, or point to, the ſame ſtar in the heavens.

Thus (at London) I find Capella E. by S. about 75° high: Pollux and Caſtor, the firſt about 40°, and the latter about 45° high, near the E. point. Procyon below them, to the left hand, 23° high, E. S. E. Sirius yet lower, to the left, S. E. about 10° high; Betelgueze on the ſame point, and about 38° high; Rigel, more ſouthward, about 26° high; Aldebaran, on the ſame point, much higher, viz. about 53° high; the Seven Stars, or Pleiades, S. nearly about 62° high; Mencar, S. by W. 40° high.

Hence you will readily diſtinguiſh the principal ſtars, as they appear in the heavens, at any given time and place. Rectify the globe for the time and place, and then obſerving ſome ſtar which you know as one of the pointers in the Great Bear,* or Sirius; find the ſame on the globe, and take notice of the poſition of the contiguous ſtars in the ſame or an adjoining conſtellation; direct your ſight to the heavens, and you will ſee thoſe ſtars in the ſame ſituation: thus you may proceed from one conſtellation to another, till you have learned moſt of the principal ſtars. Take as an example, the ſituation of the ſtars at London on the 9th of February, at nine in the evening.—Sirius, or the Dog Star, will be on the meridian; its altitude 22°; Procyon, or the little Dog, 16° towards the eaſt; its altitude $43\frac{1}{2}$: ſomething more towards the eaſt are Caſtor and Pollux, about 24° above Procyon: S. E. 65° and 35° in height is Regulus or Cor Leonis. Due Eaſt, and 22° in height, is the ſtar Denib Alaſed in the Lion's tail: 30° from the Eaſt towards the north is Arcturus, about 3° above the horizon: directly above Arcturus, and 31° above the horizon, is Cor Caroli: in the North Eaſt are, the ſtar in the extremity of the Great Bear's tail; Aliath, the firſt ſtar in the tail; and Dubbe, the northernmoſt pointer in the ſame conſtellation: the altitude of the firſt is 50°; of the ſecond 41°; and of the third 56°.

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* The two ſtars in the Great Bear are called *Pointers*, becauſe a line drawn through them points to the pole ſtar.

Reckoning weſtward, we ſee the beautiful conſtellation Orion, the middle ſtar of the three in his belt is S. 20° W. its altitude is 35°. Nine degrees below his belt, and a little more to the Weſt, is Rigel, the bright ſtar in his heel. S. 49° W. and about 45° above the horizon, is Aldebaran, the Bull's eye. A line joining this laſt and Sirius paſſes but little above Orion's belt, the middle ſtar in which is equally diſtant from each. A little to the Weſt of Aldebaran are the Hyades, and about S. 70° W. are the Pleiades: in the W. by S. point is Capella, in Auriga. In the N. W. and about 42° high, is the conſtellation Caſſiopeia; and almoſt in the N. near the horizon, is the conſtellation Cygnus.

PROB. LXIII.

To tell the Time of the achronical riſing and ſetting of the Stars.

DEF.—1. THE achronical riſing of a ſtar is when the ſtar riſes juſt at ſun-ſet.

2. A ſtar is ſaid to ſet achronically, when it ſets with the ſun.

Rule. Bring the ſun's place, for the given day, to the weſtern ſide of the horizon, and all thoſe ſtars that are on, or near, the Eaſtern ſide of the horizon, riſe achronically; and thoſe on the Weſtern verge of the horizon ſet achronically.

Thus I find on December the 6th, that Aldebaran riſes achronically, but it ſets achronically on May the 21ſt. Alſo Sirius riſes achronically on February the 4th, and ſets achronically on May the 14th.

PROB. LXIV.

To tell the coſmical riſing and ſetting of the Stars in any Latitude.

Def. 1. A STAR is ſaid to riſe coſmically, when it riſes with the ſun.

2. A ſtar is ſaid to ſet coſmically, when it ſets at ſun-riſing.

Rule. Rectify the globe, &c. and bring the ſun's place to the eaſtern ſide of the horizon for the given day, then all thoſe ſtars cut by the eaſtern edge of the horizon riſe coſmically. The globe ſtill remaining in the ſame poſition, look at the weſtern edge of the horizon, and all thoſe ſtars cut by it, or that are very near it, ſet on that day coſmically.

Thus I find that Arcturus, and two ſmall ſtars in Hercules's Thigh, riſe coſmically September the 25th. Alſo two ſtars in Eridanus, Lyra, &c. &c. ſet coſmically. Markab in Pegaſus is but juſt below the horizon, therefore may be ſaid to ſet nearly coſmical, as it will within a day or two.

FOR THE COSMICAL SETTING.

Turn the globe till the ſtar comes to the weſtern ſide of the horizon, and obſerve the degrees of the ecliptic then cut by the eaſtern ſide of the horizon, for that will anſwer to the day of the coſmical ſetting.

Thus Arcturus ſets coſmically June the 22d. Alſo Aldebaran ſets coſmically November the 25th.

PROB. LXV.

To tell the heliacal riſing, or ſetting of the Stars.

DEF. 1. HELIACAL RISING is when a ſtar once immerſed in the ſun's beams, gets out of them, ſo as to be ſeen at the eaſtern edge of the horizon, juſt before ſun-riſing.

2. Heliacal SETTING is when a ſtar, once out of the ſun's beams, gets into them ſo as to become inviſible after ſun-ſet.

RULE. To find the heliacal RISING: rectify the globe, and bring the given ſtar to the eaſtern verge of the horizon; then fix the globe, and turn the quadrant to the weſtern ſide, till 12° of the quadrant touches the ecliptic; this done, note the degree of the ecliptic that is cut by 12° of the quadrant on the weſtern ſide (for then will the real place of the ſun be depreſſed 12° on the eaſtern ſide), and that degree ſought in the calendar gives the heliacal riſing. The heliacal SETTING is found in the ſame manner, by turning the quadrant to the eaſtern ſide. Thus you will find Aldebaran riſes heliacally July the 4th, and ſets heliacally May the 5th.

Arcturus riſes heliacally at Jeruſalem October 20th, and ſets heliacally November the 5th.

And Sirius the Dog Star riſes heliacally about Auguſt the 26th.*

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* *Note* 1.—This heliacal riſing and ſetting of the ſtars is different according to their different magnitudes. For,

2.—Stars of the firſt magnitude are ſeen at riſing and ſetting, when the ſun is but 12° below the horizon. Stars of the 2d magnitude are not perfectly ſeen till the ſun is 13° below the horizon. Thoſe of the 3d degree, when he is 14°. Thoſe of the 4th degree of magnitude, when he is 15° below the horizon. Thoſe of the 5th degree, when he is 16°. Thoſe of the 6th degree, when he is 17°; and the nebulous, or ſmall ones, not until he is 18° below the horizon, viz. about the beginning and ending of twilight.

3.—The ancient poets make frequent mention of the ſtars riſing and ſetting in theſe three ways, which, for that reaſon, are ſometimes called *poetical*. The ſame poets likewiſe, and other writers, uſed to reckon their Dies Caniculares, or Dog Days, from the heliacal riſing of Sirius; but they did not agree when they ended. Some reckoned them to continue 30 or 40, and others 50 days. However, in this they agree, that the weather was very hot and ſultry for five or ſix weeks after the riſing of Sirius. But as it was then, ſo it is now, without reaſon; for Sirius does not now riſe heliacally till near September, though our almanack makers continue to reckon the beginning of Dog Days from July the 30th. It is plain, however, that Sirius can no ways be charged with bringing this ſultry weather; becauſe three or four thouſand years hence he will not riſe heliacally till November, and then, perhaps, will be charged with bringing as much cold as he has hitherto been accuſed of bringing heat.

PROB. LXVI.

To explain the Appearances of the Harveſt Moon at LONDON.

THE moon proceeds daily in her orbit about 13°, and loſes about 48′ a day, one day with another, in the time of her riſing; but yet ſhe loſes more when ſhe is in one part of her orbit, and leſs in another; which is occaſioned by the moon's path (which may, without much error, be conſidered the ſame as the ecliptic), lying in ſome parts more oblique to the horizon than others. By turning the globe, it will be ſeen that the angle made with the ecliptic and horizon is *leaſt* when Aries is brought to the eaſtern edge of the horizon, and *greateſt* when Libra is brought to the ſame eaſtern edge. Place a ſmall patch on the firſt of Aries, to repreſent the moon's place, and another at the diſtance of 13°, the moon's daily motion from the ſun: then having brought the firſt patch to the horizon, ſet the index to xii o'clock, and turn the globe exactly one round, when the index will be at xii again, and the ſame patch will be in the horizon; but the moon has in the mean time advanced to the other patch, and the globe muſt be turned in order to bring that ſecond patch to the horizon, till the index points to 21 minutes; therefore the moon, when in the beginning of Aries, riſes on two ſucceſſive days with only 21 minutes difference of time. Again, place two patches, in the ſame manner, at the beginning of Libra, and there will be found 1 hour 12 minutes difference of time in the two riſings; and if patches be placed on any other part of the ecliptic, the difference will be leſs or more between the two extremes, according as the part of the ecliptic is nearer to Aries or to Libra. It is therefore evident, that as the moon goes through the ecliptic in a month, there muſt be ſome days in every month in which there will be the ſame ſmall difference in the moon's riſing as was firſt found. But its riſing is never ſo much obſerved as when at the full: and the time it riſes for ſeveral evenings about its full with the leaſt difference, is when the ſun is near the beginning of Libra, as the ſun's place is, at full moon, oppoſite to the moon; conſequently that time muſt be about the beginning or middle of September.

If there be three or four patches put at the diſtance of about 13° on each ſide of the firſt of Aries, and on each ſide of the firſt of Libra; the difference of time, during the riſing of ſeven of the former, will be only about two hours and three quarters, while in the latter ſeven it will be eight hours and a quarter. Whence it follows, that when the moon is full in harveſt, it differs but two hours and three quarters in its riſing for a whole week; and as it riſes as ſoon as the ſun ſets for ſeveral ſucceſſive evenings, its regular riſing is ſubject to general obſervation.

The above difference is ſuch as happens when the moon is in the ecliptic; but if it be *ſouth* of that line, the angle which the moon's orbit makes with the horizon will be greater, and conſequently there will be greater difference of time in the moon's riſing during ſeven days, which in ſome caſes may be equal to more than three hours and a half. On the other hand, if it is *north* of the ecliptic, the angle which its orbit makes with the horizon will be much leſs, and the difference of its riſing in ſeven days will not, in the moſt favourable ſituations, be more than an hour and three quarters.

Hence it appears, that the harveſt moon is not equally beneficial in all years, and that it depends on the moon's latitude when in Piſces and Aries. In the year 1783 it was the moſt beneficial, and in 1792 it was the leaſt ſo; and as the harveſt-moons go through a whole courſe of the moſt and leaſt beneficial ſtates every nineteen years; the moſt beneficial was again in 1802, and the leaſt will be in 1821.

PROB. LXVII.

The Latitude and Day given (ſuppoſe at LONDON, November *the 5th) to tell,*

1. THE riſing and ſetting of the ſun, and the point he riſes and ſets upon.
2. His meridian altitude.
3. His altitude at any hour, ſuppoſe ten in the morning.
4. His right and oblique aſcenſion.
5. His aſcenſional difference.
6. His amplitude at riſing.
7. His azimuth at ten in the morning.
8. His almacanter at the ſame time.

9. The time he is due E.*
10. The length of day and night.
11. The length of twilight.
12. The length of the real night.
13. The people to whom he will be vertical that day.
14. The very place to which he will be vertical at ten o'clock at night at London. Alſo,
15. To tell what time Aldebaran, or any other ſtar, will riſe and ſet that night.
16. To tell alſo what time any ſtar will be due E. or W. (ſuppoſe Aldebaran), what is its amplitude at riſing and ſetting, its azimuth at eight at night, and the time of its being full S. Alſo,
17. To tell what point of the compaſs the Pointers will then be on, and what time they will be on the meridian above and under the pole ſtar.

Tyro. You may depend, Sir, upon my trying to work theſe problems the firſt opportunity.

Philo. And in order to make you not only perfect, but familiar in the uſe of the globes, let me recommend you to ſet down the anſwers in writing.

Tyro. I will, and ſhew them to you when we meet next.

Philo. Afterwards it will be an uſeful exerciſe to do the ſame ſeries of problems for the latitude of Liſbon, Peterſburgh, and Madras.

Tyro. I ſhall be glad to purſue theſe exerciſes till they are perfectly familiar to me.

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* To find what time the ſun will be due eaſt when he is below the horizon, find the time when his oppoſite place will be due weſt, and *vice verſa.*

SECT. II.

Containing ſome uſeful PROBLEMS *in* NAVIGATION.

PROB. I.

The Sun's Declination, and Hour when he is due E. *being given, to find the Latitude, viz. the Elevation of the Pole.*

RULE. RECTIFY the globe to the ſame latitude as the given number of degrees of declination, and fix the quadrant in the zenith; then convert the hours that the ſun is due E. before, or after ſix o'clock, into degrees, and count the ſame number of degrees on the horizon, from the E. point ſouthwards, and bring the quadrant to that degree of the horizon, ſo ſhall the degree on the quadrant that is cut by the equator be the complement of latitude, which taken from 90°, gives the latitude itſelf, or height of the pole.

Ex.—Sailing May the 21ſt, I made an obſervation that the ſun was due E. about ſeven minutes paſt ſeven in the morning, and his declination 20° N. I demand what latitude I was in.

Proceed by the rule, you will find the latitude to be 51° 30′ nearly; for the quadrant being made to cut the horizon about 17° S. of the Eaſt, it will be cut by the equator in 38°½.

PROB. II.

Having the Sun's Azimuth at ſix o'Clock, and Declination, to find the Latitude.

Rule.—AS many degrees as are contained in the given azimuth, ſo much elevate the pole, and fix the quadrant in the zenith, and bring ♈ to the meridian: this done, count on the quadrant upwards, the complement of the ſun's declination to 90°, and bring that degree to the equator, then the degree of the horizon, cut by the quadrant, will be the complement of latitude, counted from the E. point, or elſe from the W. as it may happen, and what this ſum wants of 90° is the latitude required; or otherwiſe, the degrees counted from the other two cardinal points, either N. or S. as it may happen, will give the latitude.

Ex.—I find the ſun's azimuth, at ſix o'clock, to be 12° 46′, and his declination 20°, what is the latitude? Work according to the rule, and you will have the anſwer 38° 30′ complement, that is, 51° 30′, latitude required: for rectify the globe for 12° 46′, and the zenith; then bring ♈ to the meridian, and move the quadrant till 70° cut the equator, and the degree in the horizon will be $38\frac{1}{2}$.

PROB. III.

The Sun's Amplitude and aſcenſional Difference being given, to find the Elevation of the Pole, and Sun's Declination.

Rule.—RAISE or elevate the pole ſo many

degrees as is the aſcenſional difference, fix the quadrant in the zenith, bring ♈ to the meridian, then count on the quadrant upward the complement of ampltitude, and move the quadrant, till the ſame number on the quadrant cuts the equator; the quadrant will then cut the horizon in the degree of the pole's elevation, and the equator in the degree of declination.

Ex.—I made an obſervation, that the ſun's aſcenſional difference was 27° 30′, and his amplitude 33° 38′; I demand the latitude and declination.

Proceed according to the rule, and you will find the latitude 51° 30′, and the declination 21° 10′.

~~degree of declination and the Equa~~
~~in the degree of the Pole's Elevation~~

PROB. IV.

The Sun's Altitude E. *and his Declination being given, to find the Elevation of the Pole.*

Rule.—ELEVATE the pole to the complement of the ſun's altitude at E. and fix the quadrant in the zenith, and bring ♈ to the meridian, then note on the quadrant of altitude the degree of declination, and bringing the ſame to the equator, obſerve what degree the quadrant cuts the equator in; for its complement to 90° is the height of the pole.

Ex.—The ſun's declination being 20° 10′ N. his altitude E. (at London) 26° 8′, I would know whether the ſuppoſed latitude ($51\frac{1}{2}$) agrees herewith in operation?

Here I ſubtract 26° 8′ from 90°, and there remains 63° 52′, complement of altitude, and I elevate the pole accordingly, &c. Then I bring ♈ to the meridian, and cauſe 20° 10′ on the quadrant to cut the equator, and find it 38° 30′, the complement of latitude required; which ſubtracted from 90°, gives 51° 30′, the real latitude of the place.

PROB. V.

The Sun's Declination and Amplitude being given, to find the Height of the Pole.

Rule.—ELEVATE the pole to the complement of amplitude, and fix the quadrant in the zenith, and bring ♈ to the meridian, then count the ſun's declination on the quadrant, and bring that degree to the equator; and the degree of the equator, cut by the quadrant, is the height of the pole, or the latitude required.

Ex.—Suppoſe the ſun's amplitude 33° 38′, and his declination 20° 10′, what is the latitude?

Proceed according to rule, and you will find it about 51° 30′.

There are many other queſtions relating to Navigation, which may be deduced from theſe, and performed on the globes; which you will find treated of hereafter.

SECT. II.

Containing ſome practical Problems, relating to Spherical Triangles, applied in ſome meaſure to Navigation, Dialling, &c. by which the learner wlll ſee more of the Nature of the Doctrine of the Sphere, than he poſſibly can do by way of Plane.

AND it muſt be obſerved,

1. That every triangle has three ſides and three angles.

2. The perpendicular (called alſo Cathetus) ſhall be here repreſented by, or placed on, the brazen meridian itſelf.

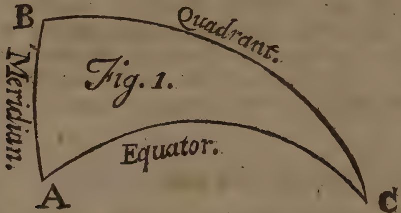
3. The baſe ſhall be placed in general upon the equator.

4. The hypothenuſe (or diagonal line) is repreſented by the quadrant fixed to the zenith, and turned to the extremities of the perpendicular and baſe, which will form a complete right-angled triangle.

5. A right-angled triangle is ſuch as has one of the angles right, or that contains 90°. An acute angle is leſs than 90°, and an obtuſe angle is more than 90°.

PROB. I.

In the right-angled ſpherical Triangle ABC, *let the Perpendicular* AB *be* 42° 30′, *the Baſe* AC 60° 15′; *I demand the Hypothenuſe* BC.



BRING ♈ to the brazen meridian, and there faſten the globe: then count from Aries 42° 30′ on the brazen meridian, which is the perpendicular, and at 42° 30′ fix the quadrant of altitude. Then count from Aries on the equator 60° 15′, which will repreſent the baſe; and note well the degree on the equator, or elſe make a ſmall dot: This done, turn the quadrant till the figured edge of it touches the equator at 60° 15′; and the degrees on the quadrant from the equator to the zenith will be the hypothenuſe required; viz. about 68° 15′.*

Thus you will find when the perpendicular is 55° 45′, and the baſe 70° 30′, the hypothenuſe will be 79° 30′ nearly.

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* *Note.* It is not neceſſary in theſe ſort of Problems, to elevate the pole to the number of degrees of the perpendicular; for the anſwer will be the ſame whether you do ſo, or not.

PROB. II.

The Baſe AC 60° 15′, *and Hypothenuſe* BC 68° *given, to find the Perpendicular* AB.

Rule.—COUNT from Aries on the equator the baſe AC, and let the quadrant be on the meridian, without being fixed faſt, ſo that you may ſlip it backward and forward, till 68° of it (which is the hypothenuſe BC) juſt touches 60° 15′ on the equator; for then will the meridian, from Aries to the nut of the quadrant, tell you the perpendicular AB, viz. 42° 30′. See the figure. Alſo, let the baſe AC be 66° 30′, and the hypothenuſe BC be 75°, AB the perpendicular will be 49° 32′.

PROB. III.

The Perpendicular AB 42° 30′, *Hypothenuſe* BC 68° 15′ *given, to find the Baſe* AC.

Rule.—COUNT from Aries on the meridian 42° 30′ the perpendicular AB, and there fix the quadrant; then turn the quadrant till 68° on the quadrant from the zenith, touches the equator, and the degrees on the equator intercepted between the point Aries, and the quadrant, ſhew you the baſe AC; viz. 60° 15′: See the figure. Alſo, let the perpendicular AB be 35°, and the hypothenuſe BC be 81° 30′, AC the baſe will be 79° 36′.

Tyro. I think I underſtand the operations.

Philo. Hence you may obſerve, the meridian cuts the horizon, as well as the equator, at right angles; therefore, by counting the perpendicular from the horizon on the meridian, the quadrant will ſtill be the hypothenuſe, and will cut the horizon at the extremity, or degree of the baſe, as it did the equator before.

From which ariſe the following obſervations.

I. The N. and S. points of the brazen meridian being 180° diſtant, it is plain that the quadrant of altitude fixed in the zenith will (however extended) make two angles equal to 180°, or half the circle. For inſtance, if I lay the quadrant from the zenith to the E. or W. points, I then have two right angles, each equal to 90°, viz. together equal to 180°; and if I move the quadrant from theſe points, ſuppoſe 30°, to the N. or the S. I ſtill have two angles made by the quadrant, the meridian and horizon equal to 180°: viz. one of them equal to 120°, and the other equal to 60°.

II. Hence it alſo appears, that you may, by a little attention, find the length of any ſide, or the angle formed by any two ſides of a triangle; viz. whether it be an acute angle, which is leſs than 90°, or an obtuſe angle, which is greater than 90°.

PROB. IV.

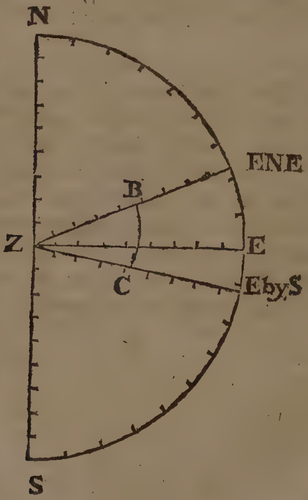
A Ship ſails from N. *Latitude* 55° 45′ *in a direct Courſe, till ſhe comes to the* Equator, *and her Difference of Longitude is* 76° 30′ E. *from the Place whence ſhe departed: I demand the Rhumb in Navigation ſhe is then upon, and the Diſtance from the Place ſhe ſailed from, allowing* 60 *Miles to a Degree, and her Diſtance in an Arch of a great Circle, viz.* 69½ *Miles to a Degree?*

Ans.—The rhumb the ſhip is upon being EbS. rectify the globe for 55° 41′, and fix the quadrant on the zenith. Bring Aries to the meridian, and count 76° 30′ on the equator, and at that point let the quadrant cut the equator, and the horizon will be cut EbS. and the quadrant at 82°, conſequently the diſtance of the place from which ſhe ſailed is 82 degrees, that is, 4920 miles, at 60 to a degree, or 5699 miles, at 69½ to a degree.

PROB. V.

Two Ships, B *and* C *ſet ſail from* Z, *in Latitude* 32° N. *and Longitude* 62° 30′ W. *from* London. B *goes* ENE. 46° 30′, *and* C *ſails* E. *by* S. 43° 30′; *I demand,*

1. *From whence they ſail.*
2. *The Places they arrive at.*
3. *The Rhumb, from the* N. *each Ship ſailed upon.*
4. *The Angle they make at ſetting out.*
5. *Their Difference of Longitude from the Place they ſet out.*
6. *Their Diſtance and Situation from each other.*



1. RECTIFY the globe to the given latitude and longitude, and Bermuda will be found to be the place they ſailed from.

2. Place the quadrant in the E. N. E. point, count from the zenith on the quadrant 46° 30′, which will give the place where the ſhip B is, viz. Gibraltar. Again, turn the quadrant to the E. by S. point, and count from the zenith 43° 30′, where you will find the place that the ſhip C arrived at, viz. Cape Verd.

3. Count the points from the N. and B will be found to have ſailed on rhumb 6, and C on rhumb ~~9~~ 8

4. The degrees on the horizon from the E.N.E. to the E. by S. will ſhew the angle they made at ſetting out, viz. 33° 45′.

5. Bring the place each ſhip arrived at to the meridian ſeparately, it will ſhew you the difference of their meridian from the firſt ſetting out, viz. B 57° 30′, C 45° 30′, both eaſtward. Their difference of longitude at their return is 12°.

6. For their diſtance, bring either of the places arrived at, ſuppoſe Gibraltar, to the meridian, elevate the pole, and fix the quadrant in the zenith; extend it to Cape Verd, and you will find it 24° S. S. W. which, multiplied by 60, gives 1440 miles.

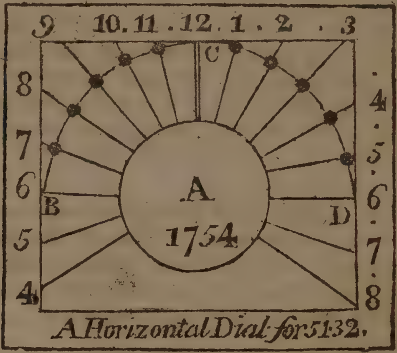
Philo. I ſhall now ſhew you how to make a common dial, from whence you will naturally ſee the properties of the ſphere more plainly, and by the interſection of the different circles, will yourſelf be able to work many curious and uſeful Problems.

PROB. VI.

To make an horizontal Dial (viz. a Dial to be ſet upon a Poſt, or Pedeſtal) in any Latitude; but ſuppoſe for London.

Ex.—LET it be required to make an horizontal dial for the latitude of London.

Firſt, Take a piece of braſs, or a thick ſmooth painted piece of board, of the ſame ſize as that of which you would have your dial:



A Horizontal Dial for 51·32.

and deſcribe upon it a ſemicircle at pleaſure from the centre A, as B C D.

Secondly, Divide this ſemicircle into two equal parts by the line A 12.

Thirdly, Draw right lines by the extremity of the ſemicircle, ſo as to make them tangents to it at B, C, and D; theſe are to contain the hour lines; and thus is your plane, or dial-plate, ready to have the hours drawn from the centre.

Now to find the diſtance from the meridian, or 12 o'clock line, in degrees and minutes,

Rule I. is, Bring the vernal colure (viz. ♈) to the meridian, and the index to the upper 12; this done, turn the globe weſtward, till the index points to one o'clock, (or till 15 degrees paſs through the meridian), and you will find the colure (viz. the line that paſſes through Aries from pole to pole) to cut the horizon in 11° 51′ from the meridian, the diſtance from the 12 o'clock line to 1, or 11, which ſet off by any ſcale of chords from the meridian 12 on the ſemicircle.

Secondly, Turn the globe till the index points to 2, and the colure will cut the horizon in 24° 19′, the diſtance from 12 to 2 or 10: turn the globe till the index points to 3, and the colure will cut the horizon from the meridian in about 38° 3′, the diſtance from the meridian to 3 or 9: turn it till the index points to 4, and the colure will cut the horizon in 53° 35′, the diſtance from 12 to 4 or 8. Turn it till the index points to 5, and the colure will cut the horizon in 71° 6′, the diſtance from the meridian, or 12 o'clock line, to 5 or to 7. The 6 o'clock line will be 90° from the meridian, or 12 o'clock, or will fall into the arch CD in the point D, viz. the colure will cut the horizon at 90°, or in the eaſt point.

Thirdly, Take off theſe degrees and minutes from any ſector or ſcale of chords: and ſetting one foot of the compaſs in C, ſet off on the circle from C towards B and D 11°, 51′, 24°, 19′, &c. &c.

Fourthly, From the centre A draw lines through theſe dots, to the tangents or lines without the ſemicircle, and you have the true hour lines.

Always remember to make an allowance for the thickneſs of the ſtyle or gnomon on the plane, by drawing two lines by the ſide of the meridian line, as wide as the ſtyle is thick.

Note 1. The halves and quarters are found the ſame way, by turning the globe till the index points to ½ paſt 12, ½ paſt 1, &c. and obſerving in how many degrees the colure cuts the horizon from the meridian.

2. After you have drawn the hours from 12 to 6 in the morning, and 6 in the evening, you may eaſily get the hours at 5 and 4 in the morning, by laying a ruler from the hours of 5 and 4 in the afternoon, and drawing lines through the centre. The ſame may be done on the other ſide of the plane, that is, lines drawn from 7 and 8 in the morning, will be 7 and 8 at night.

3. The ſtyle or gnomon of this dial makes an angle with the 12 o'clock hour line of 51° 32′, and muſt be put in the centre A, and ſtand directly over the 12 o'clock line, or meridian of the plane.

PROB. VII.

To make a direct S. *Dial, in the Latitude of* London.

There are two Rules.

FIRST, let the globe remain for the latitude of London as before, and fix the quadrant in the zenith, and turn it to the E. point, or to the W. and there fix it: then turn the globe to 11 o'clock or to one, and the colure will cut the quadrant in 9° 30′.

Turn it to 10 or 2, the colure will cut the quadrant in 19° 45′, the diſtance from the meridian.

Turn it to 9 or 3, it cuts the quadrant in 31° 53′

Turn it to 8 and 4, it cuts it in 47° 8′.

Turn it to 7 and 5, it cuts it in 66° 42′.

2. Elevate the pole to the complement of London's latitude to 90, viz. to 38½ (for 38½ and 51½ make 90) then turn the globe till the index points to 11 or 1, and the colure will cut the horizon in 9° 30′; turn it to 10 or 2, the colure will cut the horizon in 19° 45′, &c. as before.

Tyro. Is there not a method of making ſun-dials by calculation?

Philo. There is; but you muſt be able to work logarithms before you can accompliſh this. I will give you an example. The operation for the example in the VIth Problem will be as follows: As Radius is to the ſine of latitude, ſo is the ſangent of the hour angle to the tangent of the horizontal diſtance. Thus to find the degree upon which the *one* o'clock hour is to be placed, I ſay as

10,000 (Rad.): 9,893645—(Sine of 51° 31′):: 9,428050 (Tang. of 15°): 9,32169, which I find by the table is equal to the tang. of 11° 51′ nearly: conſequently the *one* o'clock hour muſt be placed at the line which is 11° 51′ from the 12 o'clock hour.

To find the place for the two o'clock hour, it is as

10,000: 9,898645:: 9,76143 (tang. of 30°): 9,655084=Tang. of 24° 19′.

In the ſame manner the others may be found to any degree of accuracy.

Tyro. But this mode will only anſwer for one place, namely, London.

Philo. It will anſwer for all places whoſe latitude is the ſame as that of London.

Tyro. But I may hereafter want to make dials for other places.

Philo. That is equally eaſy: I will give you an example for the latitude of Bagdad, which is 33° 20′ N.

Tyro. In this caſe I muſt ſay as Radius: S. 33° 20′ : : Tang. 15°: the tangent of the horizontal diſtance of the *one* o'clock hour from the meridian line: that is,

As 10,000 : 9,739975 : : 9,428052 : 9,167027 = 8° 22′.

Philo. You are perfectly right; now the other diſtances are found the ſame way by ſubſtituting the tang. of 30°, 45°, &c. &c. inſtead of the tang. of 15°, and you will find the *two* o'clock line will be at 17° 36′, the *three* o'clock hour will be at 28° 47′ diſtance from the meridian, and ſo on.

Tyro. Is the ſame method adopted for calculating the hour lines for vertical dials?

Philo. Nearly ſo: inſtead of taking the latitude, you muſt take the co-latitude of the place for which the dial is to be made.

Tyro. By co-latitude do you mean the number of degrees which the latitude wants of 90°?

Philo. I do; it is alſo called the complement of latitude. Thus the co-latitude of London is 90°—51° 30′=38° 30′, and the co-latitude of any place whoſe latitude is 52° 45′, is 37° 15′.

Tyro. Suppoſe then I wiſh to make a direct ſouth-dial for Yarmouth, the latitude of which is 52° 45′, how muſt I proceed?

Philo. Say as radius : ſine 37° 15′ : : tang. of 15°, &c. to diſtance of the firſt hour line from 12 o'clock:—Thus, 10.00 : 9.781966 : : 9.428052 : 9.210038=9° 13′.

Again, for 2d hour line: 10.00 : 9.788966 : : 9.761432 : 9.543405=19° 16′.

For the 3d hour: 10.00 : 9.781966 : : 10.00 (tang. 45°) : 9.781966=31° 11′, &c.

The following table will give you the hour lines for a dial of this kind in all places the latitude of which is 52° 45′.

Forenoon	*Afternoon*	*Distance from* XII.	*Forenoon*	*Afternoon*	*Distance from* XII.
XI.	I.	9° 13′	VIII.	IV.	46° 21′
X.	II.	19 16	VII.	V.	66 8
IX.	III.	31 11	VI.	VI.	90 0

Take another example, for 12° of latitude: in this caſe the co-latitude is 78°; conſequently ſay as rad. S. 78° : : 15°, &c. and the table will be as follows:

Forenoon	*Afternoon*	*Distance from* XII.	*Forenoon*	*Afternoon*	*Distance from* XII.
XI.	I.	14° 41′	VIII.	IV.	59° 26′
X.	II.	29 27	VII.	V.	74 41
IX.	III.	44 22	VI.	VI.	90 0

Tyro. I hardly underſtand the reaſon of uſing the ſines of co-latitude inſtead of thoſe of the latitude.

Philo. You muſt remember that a vertical plane is at right angles to the horizontal plane; conſequently the plane which is *vertical* at any given place is an *horizontal* one, when referred to a place, the latitude of which is 90° from it; that is, to a place, in the oppoſite hemiſphere, having its latitude equal to the complement of the given latitude.

Tyro. Sir, I am extremely obliged to you; but if it were not too much trouble, I would take it as a favour if you would give me one example how to make a vertical dial that declines from the S. either eaſtward or weſtward; for you know that it is a mere chance that a wall ſhould exactly face the ſouth.

Philo. I am ready to do every thing, Tyro, that lies within the compaſs of time, room, and ability. We will ſuppoſe then it were required,

PROB. VIII.

To make an erect or vertical Dial, declining from the South towards the Eaſt or Weſt.

Example.

Let it be a Dial declining from the S. *eaſtward* 60°.

Rule 1.—RECTIFY the globe, quadrant, colure, and index, as before.

2. Bring the quadrant of altitude to cut the horizon in the degree of declination; viz. 60° from the N. point, eaſtward, which repreſents a plane, declining that number of degrees.

3. Hold the quadrant faſt at 60°, and turn the globe eaſtward, till the index points to all the forenoon hours, and the colure will cut the qua-

drant in the number of degrees each hour is diſtant from the meridian; and lines drawn through each of theſe from the centre, are the hours required.

1. *To find the Forenoon Hours.*

I turn the globe till the index points to 11, 10, 9, &c. or till 15°, 30, &c. of the equator paſs through the meridian, and I find the colure cuts the quadrant (from the zenith) as follows:

11	o'clock	9°	30'
10	———	18	15
9	———	26	12
8	———	35	5
7	———	45	10
6	———	57	20
5	———	76	00

The forenoon hours will be on the W. or left-hand ſide of the 12 o'clock line, becauſe the plane declines eaſtward; and conſequently you have more hours in the forenoon than in the afternoon on this plane.

2. *To find the Afternoon Hours.*

I now turn the quadrant to the oppoſite point of the horizon; viz. I cauſe it to touch 60° of the horizon from the S. towards the W. and bring the index and colure back to the meridian.

Then turning the globe weſtward, till the index points to 1, 2, 3, and 4, or till 15°, 30°, &c. paſs through the meridian, the colure will cut the quadrant (counted from the zenith) as follows:

For 1	o'clock	12°	45′
2	———	29	45
3	———	52	45
4	———	80	15

Theſe are the diſtances of the afternoon hours, from the 12 o'clock hour or meridian. Here you ſee the colure goes off the quadrant; therefore the ſun goes off this plane about 4.

3. *To find the diſtance of the Subſtyle, or place of the gnomon from the* 12 *o'clock line, as alſo the height of the ſtyle.*

Bring the colure to the horizon in the plane's declination, counted from the E. towards the S. viz. bring the colure to 60° in the horizon, counted from the E. to the S.; and then turn the quadrant till that touches the ſame number of degrees (viz. 60°) from the N. eaſtward; ſo ſhall the quadrant and colure cut each other at right angles; and the number of degrees counted on the quadrant from the colure to the zenith, are the degrees of the ſubſtyle's diſtance, viz. 21° 40′; and the degrees from the pole to where the quadrant cuts the colure, counted on the colure, is the height of the ſtyle, viz. 32° 45′.

Laſtly, Meaſure or take off 21° 40′ from any ſcale of chords, and ſetting one foot at the 12 o'clock line, turn the other weſtward, or to the left hand, and make a dot; for over this dot muſt the ſubſtyle or gnomon ſtand.

And thus by a little attention may any ſort of declining, inclining, or reclining dials be eaſily made by the globe. For a direct S. dial at London will be an horizontal dial to the inhabitants of 38° 28′ S. latitude; viz. 90° diſtance from our zenith.

So an erect plane under the pole is an horizontal one under the equator. An erect vertical at 80° N. latitude, will be a horizontal in 10° S. latitude, &c. &c.

Tyro. This gives me a clearer notion of the poſition of places and planes than I had before. But, pray, may not ſome problems relating to the moon be performed by the globes?

Philo. Yes; in the ſame way as thoſe relating to the ſun, when once you know her place in the ecliptic; but this you muſt find very often, becauſe it is continually changing, and indeed is ſo variable, that the operation will not ſtand long, or hold good but for that day only: but by getting her true place, you may tell her riſing, ſetting, and ſouthing, the hour of the night, the time of high water, &c. &c.

I will give you a ſmall notion of it, and leave the reſt to exerciſe your own ingenuity. Divide the equinoctial into 30 equal parts, by red ſtrokes or figures, beginning at Aries, and at every 12th degree making a mark, as 1, 2, 3, 4, &c. this repreſents the 30 days of her age.

Now to find her place. Elevate the N. pole to the zenith, and bring the equinoctial colure againſt the day of the month on the horizon, viz. the day of new moon, ſo ſhall the moon's age (wrote in red figures) on the equinoctial, point to the degree of the ecliptic, on the horizon, ſhe is in, or near, at that time.

APPENDIX I.

CONTAINING

A ſhort Account of the SOLAR SYSTEM, and of the Comets, and Fixed Stars.

DIALOGUE

Between PHILO, *a Tutor, and* TYRO, *a Pupil, concerning the* SOLAR SYSTEM.

TYRO. THOUGH you have given me ſome notion of aſtronomy in the ſeveral problems which relate to the ſun and ſtars, yet, as I have heard many things concerning the ſolar ſyſtem, and the comets and fixed ſtars, which I do not underſtand, I would take it as a particular favour, if you would give me a more circumſtantial account of theſe heavenly bodies.

PHILO. I will, my dear TYRO. [Turn to the centre figure in pl. SOLAR SYSTEM.] By the ſolar ſyſtem, then, you are to underſtand the ſun, which is placed in the centre, together with the ſeven planets, Mercury, Venus, the Earth, Mars, Jupiter, Saturn, and the Herſchel, which go round him. Theſe planets, with reſpect to their diſtance from the ſun, are exactly in the order in which they are here mentioned. Mercury is neareſt to the ſun, Venus next, the Earth next, Mars next, Jupiter next, Saturn next, and the Herſchel is at the greateſt diſtance of all. The diſtances of the planets from the ſun may eaſily be conceived in the following manner: ſuppoſing the diſtance of the earth from the ſun to be divided into 10 equal parts, then that of Mercury will be nearly four of ſuch parts; that of Venus 7; that of Mars 15; that of Jupiter 52; that of Saturn 95; and that of the Herſchel 190. Hence it appears, that the Earth is placed between Mars and Venus, having Mars, Jupiter, Saturn, and the Herſchel above her, or farther from the ſun, and Venus and Mercury below her, or between the earth and ſun, and for this reaſon it is, that the four firſt are called ſuperior, and the two laſt inferior planets. But to expreſs the diſtances of the planets from the ſun as nearly as poſſible in Engliſh miles, the diſtance of Mercury from it is 37 millions of miles; of Venus, 66 millions; of the Earth, 95 millions; of Mars, 144 millions; of Jupiter, 494 millions; of Saturn, 900 millions; and of the Herſchel, more than 1800 millions of miles.—By theſe diſtances, however, are to be underſtood their mean diſtances; in order to comprehend which, it muſt be obſerved, that the orbit, or path, which a planet deſcribes about the ſun, is not a perfect circle, but an ellipſis; which, though ſomewhat reſembling a circle, is longer than it is broad. Hence the ſame planet is not always at the ſame diſtance from the ſun, and it's *mean diſtance* is that point which is exactly between its greateſt and leaſt diſtance. The planets appear at firſt ſight like the fixed ſtars; but, upon a more accurate view, they may eaſily be diſtinguiſhed from them. 1. By their never twinkling, as theſe laſt do. 2. By their being ſeen earlieſt in the evening, and lateſt in the morning. And 3. By their changing their poſition with regard to the fixed ſtars, and to one another; but always keeping within the zodiac, that is, within 8 degrees of the ecliptic, either ſouth or north.—Mercury is ſo near the ſun, that, in compariſon of the other planets, he can ſeldom be ſeen. Venus is eaſily known, being ſometimes the evening, and ſometimes the morning ſtar; and Mars, Jupiter, and Saturn appear of a more red or fiery colour than the fixed ſtars.

TYRO. Do all theſe planets perform their revolutions round the ſun in the ſame time?

PHILO. No; that is not likely, conſidering their different diſtances from him. Mercury performs his revolution in leſs than three months; Venus in about ſeven months and a half; the Earth in a year; Mars in about two years; Jupiter in twelve; Saturn in about thirty years; and the Herſchel in about eighty-three years and three quarters.

TYRO. Are all the planets of the ſame bulk or magnitude?

PHILO. No: the diameter of Mercury is about 3200, of Venus 7700, of the Earth nearly 8000, of Mars 4200, of Jupiter 90,000, of Saturn 80,000, of the Herſchel 35,000 miles. And the ſun itſelf is about a million of times larger than the earth, having a diameter 100 times larger than the diameter of the earth.

TYRO. Are there not ſome ſmaller planetary bodies lately diſcovered?

PHILO. Yes: four have been diſcovered within the laſt eight years: they are all very ſmall, being but a few miles in diameter; their names are Ceres, Pallas, Veſta, and Juno.

TYRO. You ſay the earth moves round the ſun, but it appears to me that the ſun moves round the earth?

PHILO. You may naturally think ſo; but you are miſtaken; and your miſtake is eaſily accounted for from the following circumſtance, namely, that the appearance will be the ſame to you, whether the ſun moves round the earth, or the earth round the ſun. But firſt I muſt obſerve, that the earth has two motions; one on its own axis from weſt to eaſt, in twenty-four hours, which makes all the heavenly bodies appear to move round the earth from eaſt to weſt in the ſame time, and cauſes the regular ſucceſſion of day and night; and the other round the ſun in the ſpace of a year, which occaſions the change of the ſeaſons. That the appearance will be the ſame if the earth turns round its axis, as if all the heavenly bodies moved round the earth, may be eaſily proved by a very ſimple experiment. Go on board a ſhip, and let her be turned gently and uniformly round, you will not be ſenſible of the ſhip's motion, but will imagine that all the objects on land are moving round the ſhip. In like manner, let one ſhip be fixed immoveably in her ſtation; go on board another ſhip at the diſtance of two or three miles: let this ſecond ſhip ſail regularly and uniformly in a circular direction round the firſt ſhip; you will not be ſenſible of the motion of the ſhip in which you are, but will imagine that the immoveable ſhip is moving round you. The firſt of theſe is an exact repreſentation of the diurnal motion of the earth round its own axis; the ſecond, of its annual motion round the ſun.

Tyro. But though theſe motions of the earth be perfectly reconcileable to appearances, it does not therefore follow that they take place in fact.

Philo. That they do take place in fact, aſtronomers have proved by a variety of arguments, ſome of which are above your comprehenſion. I ſhall content myſelf at preſent with taking notice of one or two. In the firſt place, if the earth does not turn round its own axis, the ſun and ſtars muſt move round the earth in the ſpace of 24 hours. But conſidering the great diſtance of the ſun from us, if he were to go round the earth in 24 hours, he muſt travel upwards of 395,000 miles in a minute; and as the ſtars are at leaſt 400,000 times as far from the ſun as the ſun is from us, thoſe about the equator muſt move 400,000 times as quick as the ſun. But this is a degree of velocity, which exceeds the utmoſt ſtretch of human imagination to conceive of; and indeed it ſeems to be as impoſſible to form any idea of it, as of infinite ſpace, or eternal duration. It is, therefore, natural to conclude, that the earth turns round its axis, which is eaſily conceived, inſtead of the ſun and ſtars moving round the earth, which it is impoſſible to comprehend.

In the next place, it is an eſtabliſhed law of nature, that a heavy body never moves round a light one as its centre of motion. A pebble, faſtened to a mill-ſtone by a ſtring, may by an eaſy impulſe be made to circulate round the mill-ſtone; but no impulſe can make a mill-ſtone circulate round a looſe pebble, for the heavieſt would undoubtedly carry the lighteſt along with it wherever it goes. But the ſun is at leaſt 227 thouſand times as heavy as the earth: and therefore, inſtead of the ſun moving round the earth, not only the earth, but all the other planets, muſt move round the ſun as their centre of motion. Add to this, that, as the other planets, in their revolutions round the ſun, ſometimes move forward, ſometimes they ſeem to ſtand ſtill, and ſometimes to move backward, all theſe irregularities are eaſily accounted for by ſuppoſing the earth to move round the ſun, but cannot be explained on the contrary ſuppoſition, of the ſun's moving round the earth.*

Tyro. I beg leave, Sir, to mention one objection to the diurnal rotation of the earth on its own axis:—If it moves, as you ſay, from weſt to eaſt, will not a ball, fired perpendicularly upward in the air, fall conſiderably weſtward of the place from which it was ſhot?

Philo. By no means: for as both the gun and ball partake of the earth's motion, the ball will be carried forward with the air as quick as the earth and air turn, and will therefore fall on the very ſpot from which it was fired. Thus, if you let a ſtone fall from the top of a main-maſt, it will fall on the deck as near the foot of the maſt when the ſhip ſails as when ſhe is at reſt.

Tyro. Do the other planets, as well as the earth, turn round their axes?

Philo. Some of them do. Venus turns round her axis in 23 hours 20 minutes; Mars in 24 hours, 39 minutes; Jupiter in 9 hours, 56 minutes; and Saturn in ſomething more than 12 hours and a half. Whether Mercury, or the Herſchel, have any revolution round their axes is not yet known. The ſun turns round his axis in about 25 days; and the moon round hers in 29 days, 12 hours, and 44 minutes; that is, in the ſame time that ſhe revolves round the earth, ſo that ſhe has always the ſame face turned towards the earth.

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* *Note.* This ſubject is rendered exceedingly familiar in the II Vol. of Scientific Dialogues.

Tyro. Is not the moon one of the planets?

Philo. She is; though not a primary, but a ſecondary planet, or ſatellite; that is, an attendant upon the earth, about which ſhe revolves as her centre of motion, in the ſame manner as the earth revolves round the ſun from weſt to eaſt; and hence it is, that ſhe riſes every night conſiderably later than ſhe did the preceding one, except about the time of harveſt, when, for ſeveral nights together, ſhe riſes, when at or near full, nearly at the ſame time; for which reaſon this moon is, by way of diſtinction, called the harveſt moon. When the moon is directly between the earth and the ſun, it cauſes an eclipſe of the ſun, that is, ſhe hides the ſun from the inhabitants of the earth; and when the earth is directly between the ſun and the moon, it cauſes an eclipſe of the moon, that is, the moon is involved in the ſhadow of the earth, and cannot ſee the ſun. The former always happens at new moon; the latter at full moon. But neither of them happen at every new and full moon; for, if they did, there would be twelve eclipſes of each luminary in the courſe of a year, whereas there are never more than ſeven, nor leſs than two.——See Plate, Solar System.

Tyro. Have the other planets any moons?

Philo. Jupiter has four moons, Saturn ſeven, and the Herſchel ſix. Mercury, Venus, and Mars, have no moons, at leaſt none that have yet been diſcovered. Beſides theſe ſeven moons, Saturn is encompaſſed with two broad rings, which are probably uſeful in reflecting the light of the ſun to that planet; the breadth of the *inner* ring is 20,000 miles, that of the *outer* ring is 7,200 miles, and the vacant ſpace between the two rings is 2,839 miles.—See Plate, SOLAR SYSTEM.

TYRO. Is the moon as big as the ſun, as ſhe appears to be?

PHILO. Very far from it; her diameter is only 2,200 miles in length, ſo that ſhe is nearly 50,000,000 times leſs than the ſun. The reaſon of her appearing as big as the ſun is, that ſhe is ſo much nearer the earth. Her diſtance from the earth is only 240,000 miles, whereas that of the ſun is 95 millions.—I have in the upper part of the Plate, SOLAR SYSTEM, given you the proportional ſizes of the ſeveral planets; and on the other ſide of the Plate, the apparent magnitude of the ſun as ſeen from each planet.

TYRO. To Mercury it would appear the largeſt.

PHILO. That is owing to the ſmall diſtance which it is from the ſun compared with that of the other planets; and hence Mercury has ſo much more light and heat than they.

TYRO. Excuſe me; but I do not well ſee upon what principle theſe white circles in the Plate are made of the particular ſizes as they are there given.

PHILO. I will tell you how they are found: the apparent magnitudes of bodies are to one another inverſely as the ſquares of their diſtances.

TYRO. Do you mean that a body at the diſtance of 10 miles would appear 100 times leſs than an equal body at 1 mile diſtance?

PHILO. I do: and therefore Mercury and Venus, being the one at 37 millions of miles diſtance from the ſun, and the other at 66 millions, the magnitude of the ſun will appear more than three times larger to an inhabitant of Mercury than it will to an inhabitant of the planet Venus: becauſe the ſquare of 37 is 1369, and the ſquare of 66 is 4356, but the latter number is more than three times larger than the former, of courſe the ſun would appear to the inhabitants of Venus three times leſs than to the inhabitants of Mercury; and on this principle the white circles on the plate ſhould be made if great accuracy were required.

TYRO. What kind of bodies are the planets?

PHILO. They are dark or opaque bodies, that have no light of their own, but ſhine by the reflected light of the ſun, which is the ſource of light and heat to all other bodies in the ſolar ſyſtem.

TYRO. Pray what do the circles on the planet Jupiter repreſent? [See pl. SOLAR SYSTEM.]

PHILO. They are called the belts of Jupiter; and may be ſeen on the ſurface of the planet with a good teleſcope. Theſe belts have been ſuppoſed to be clouds floating in the atmoſphere that ſurrounds Jupiter. Accurate obſervers have noticed that the belts revolve ſomewhat ſlower than the planet itſelf.

TYRO. The planet Saturn ſeems to have a curious appearance, but it is very like what I ſaw through your teleſcope.

PHILO. The moſt remarkable circumſtance attending him is a double ring repreſented in the plate, which ſeems ſuſpended over his equator, and revolves with a rapidity almoſt as great as that of the planet. This ring is probably very uſeful in reflecting the light of the ſun to the planet.

I will mention another circumſtance relating to theſe planets. We have, you know, 365 days in our year. The inhabitants of Jupiter have nearly 10,000 days to their year; and thoſe of Saturn have 30,000 days to their year.

TYRO. Are the planets inhabited?

PHILO. They probably are; for it is not to be ſuppoſed that the Almighty created ſo many worlds for no other purpoſe than merely to afford a faint glimmering light to the inhabitants of this earth, eſpecially as we might have enjoyed a much greater light at a far leſs expence, namely, by the addition of another moon.

TYRO. What do you mean by the comets?

PHILO. The comets are certain dark or opaque bodies, like the planets, and move round the ſun, but in very eccentric orbits, being ſometimes ſo far from him, that their cold muſt be exceſſive, and ſometimes ſo near him, that their heat muſt be ſo intenſe, as would prove altogether intolerable to an inhabitant of this earth; and would even deſtroy, or at leaſt vitrify, or turn to glaſs, the earth itſelf. Sir Iſaac Newton computed the heat of the comet which appeared in 1680, when neareſt the ſun, to be 2000 times greater than that of red-hot iron; and being thus heated, it muſt retain its heat until it come round again, although its period ſhould be more than 20,000 years; and it is computed to be only 575. The theory of comets is not as yet very diſtinctly aſcertained. There are ſuppoſed to be 21 comets belonging to the ſolar ſyſtem; but the periods or returns of three of them only are known with any tolerable certainty. One of them was expected to return in 1789, but has not yet appeared. Comets are always attended with long tranſparent trains or tails, iſſuing from that ſide of them which is turned away from the ſun. Comets were formerly ſuppoſed to be prodigies or portents, and to foretel ſome great event or revolution, ſuch as the fall of empires, or the death of ſome eminent and diſtinguiſhed perſonage; but they are now known to have no more connection with the civil or political affairs of this world, than any other of the heavenly bodies.

Tyro. What do you mean by the fixed ſtars?

Philo. All the other heavenly bodies, except the ſun, planets, and comets. They are called fixed ſtars, becauſe they always keep the ſame place, or relative diſtance from one another.—Their number is probably infinite; but thoſe diſcoverable by the naked eye, at one time, do not exceed 1000.* Their appearing ſo numerous, or rather numberleſs, to the naked eye, is owing to our looking upon them in a confuſed manner, and without reducing them to order. They are ſuppoſed to be ſuns, and to have planets, both primary and ſecondary, revolving round them. What a grand and exalted idea does this give us of the works of creation, and of the power, wiſdom, and goodneſs of the adorable Creator!

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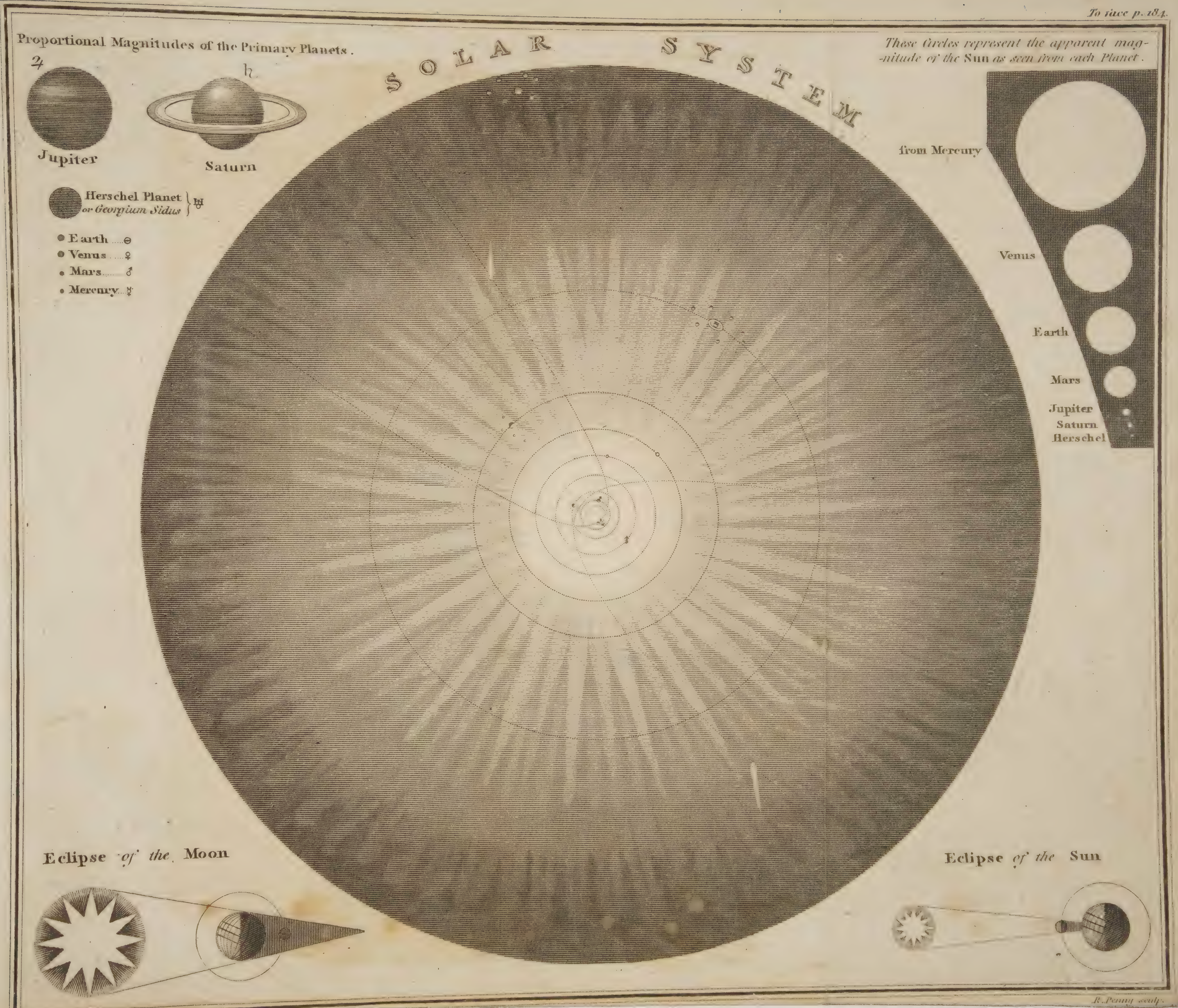
* *Note.*—The cauſe of this deception is fully explained in the 1ſt Converſation of Vol. II. of Scientific Dialogues.

To face p. 184.



R. Penny sculp.

APPENDIX II.

SECT. I.

Concerning the true Figure and Magnitude of the EARTH, *with the Proportion of* LAND *and* WATER *on its Surface.*

THOUGH the earth be round, as we hope we have clearly demonſtrated, in the beginning of this work, yet it is not an exact globe or ſphere, but only a ſpheroid; that is, a figure ſomewhat approaching to, or reſembling a ſphere, being flatted (like an orange) towards the poles, and ſwelling out towards the equator. This protuberance of the equatorial parts, and ſhrinking in of the polar regions, is owing to the centrifugal force ariſing from the earth's turning round its own axis in the ſpace of twenty-four hours: it is the ſame force, which a ſtone in a ſling is known to acquire by being ſwiftly whirled round in a circular manner, and by which it has a ſtrong tendency to recede or fly from the hand, or centre of motion. In like manner, all the parts of the earth endeavour to fly off from the axis of motion, and would actually do ſo if they were not kept together by a far ſuperior force, viz. that of gravity, by which they conſtantly tend towards the earth's centre: this laſt, therefore, is called the centripetal force, and acts in direct oppoſition to the centrifugal.

When a ſtrong and a weak force act in oppoſition to each other, the effect of the former will be diminiſhed by the latter; and as the centrifugal force is greater in the parts about the equator, where the diſtance from the axis is greateſt of all, ſo the force of gravity will be there moſt diminiſhed by it, and conſequently all thoſe parts muſt have receded farther from the centre than they were when the earth was firſt put in motion; and as all the parts of the earth are connected by a mutual coheſion, it follows, that in proportion as the equatorial parts receded, the polar parts muſt have approached nearer to the centre, and therefore muſt have become flatter than the other parts; that is, the earth muſt have aſſumed the figure, not of a globe or ſphere, but of a ſpheroid. It appears, from the principles of phyſics, that the force of gravity, or the centripetal force, is to the centrifugal as 289 to 1 under the equator; and the latter gradually decreaſes as you retire from the equator towards the poles, at which two laſt places it ceaſes to act entirely; for as there is no rotatory motion at the poles of the earth, there is conſequently no centrifugal force, and in theſe two points therefore gravity exerts its full effect.

Now, ſince gravity gradually encreaſes from the equator to the poles, it will have a ſenſible influence upon the motion of long pendulums by increaſing or diminiſhing their weight, in proportion as they are carried nearer to the poles or the equator; for, according as their weight is greater, they vibrate the quicker, and *vice verſa:* therefore a pendulum of a given length, which vibrates ſeconds at London, will not do the ſame at the equator, where gravity is leſs, and conſequently the pendulum lighter; for there it will vibrate ſlower, and the clock will by that means loſe time. The truth is, it was the irregular going of a pendulum clock which firſt ſuggeſted the idea of the different force of gravity in different latitudes; for in 1672, M. Richer carried a clock from Paris to Cayenne, in north lat. 4° 56′ 17″, where he found, that, in order to its beating ſeconds of mean time, it was neceſſary to ſhorten the pendulum one line and a quarter, or a little more than one tenth of an inch; which plainly proved that gravity was leſs there than at Paris or London.

The ſpheroidical figure of the earth being once aſcertained, the next point to be determined was how much it differed from a real ſphere; and this, it was thought, might moſt effectually be done by meaſuring a degree of the meridian: for it was well known, that, if the figure was not ſpherical, the degrees could not be equal in different latitudes, but muſt be leſs near the equator, where the earth was rounder, and greater towards the poles, where it was flatter.

This taſk, therefore, of meaſuring a degree of the meridian, was firſt undertaken by the celebrated Caſſini, who in 1718 meaſured the length of the meridian through France, and found that a degree in the parallel of 49° 22′ was equal to 57,183 toiſes. In 1735, by the joint orders of the Kings of France and Spain, a degree was meaſured at Quito, in Peru, in latitude 1° 10′, and was found there equal to 56,767⅘ toiſes. In 1736, by the French King's order, a degree was meaſured at the Arctic circle, and found to contain 57,438 toiſes. Eight hundred and twenty-four toiſes are about equal to an Engliſh mile.

From theſe ſeveral meaſures of a degree in the different parts of the meridian, it is found by calculation, that the axis of the earth, (that is, the diameter between the poles,) is to a diameter of the equator as 229 to 230; which makes the equatorial diameter exceed the polar by about 34 miles. By the ſame calculation it is likewiſe found, that a degree at the pole exceeds a degree at the equator by 830 toiſes, or a little more than an Engliſh mile; and that a degree of the meridian in the parallel of 54° 44′ is equal to a degree on the equator, which exceeds the firſt degree of the meridian by 546 toiſes. If we add the toiſes in the two extreme degrees of the meridian together, half the ſum will be 57,041, which is the length of a mean degree, or degree in the meridian of a globe juſt equal in bulk to our ſpheroidical earth. Then divide 57,041 by 824, and the quotient will be the length of a degree in a great circle of ſuch a globle; which multiplied by 360, will give 24,922 miles for the circumference of a globe equal to the earth; whoſe diameter therefore will be 7933 Engliſh miles.— The diameter of the earth being known, the ſquare miles contained in its ſurface will be 197,706,226; and its ſolid contents in cubic miles will be upwards of 26,139,500,000, or nearly 26,140 millions.

As to the proportion, which the land bears to the water on the ſurface of the earth, it is perhaps impoſſible to determine it exactly. Some probable conjecture, however, may be formed with regard to it by the following experiment:—Suppoſe, of the papers that cover the artificial globe, you cut out carefully, with a pair of ſciſſars, thoſe parts that repreſent land, and weigh them in a nice balance. Then do the ſame with thoſe parts that repreſent water, and the weight of the two parcels of paper, compared together, will give you the proportion of the land to the water.

This I have ſeen done with the papers that cover the ſurface of Mr. Senex's 28 inch globe, and the reſult was as follows.—The papers repreſenting land weighed 367 grains, and thoſe repreſenting water 1125 grains. The weight therefore of the whole was 1492 grains, and the weight of the land being 367, the proportion of land to water is as 1 to 3 nearly, or the land is only about $\frac{1}{4}$ of the earth's ſurface.

SECT. II.

Of the ATMOSPHERE.

THE air is that thin, inviſible fluid, which ſurrounds the earth to a conſiderable height, and accompanies it in its diurnal motion about its own axis, and in its annual motion round the ſun. In ſhort, it is that in which we live and breathe, and, together with the clouds and vapours that float in it, is called the atmoſphere. The air is juſtly reckoned among the number of fluids, becauſe it has all the properties by which a fluid is diſtinguiſhed. It yields to the ſmalleſt force impreſſed on it; its parts are eaſily moved among themſelves; it preſſes according to its perpendicular height, and its preſſure is every way equal.

That the air is a fluid, conſiſting of ſuch particles as have no coheſion betwixt them, but eaſily glide over one another, and yield to the ſlighteſt impreſſion, appears from that eaſe and freedom with which animals breathe in it, and move through it without any difficulty or ſenſible reſiſtance. But it differs from all other fluids in the four following particulars:—1. It can be compreſſed into a much leſs ſpace than that which it naturally occupies, which no other fluid can, at leaſt not to any conſiderable degree.* 2. It cannot be congealed or fixed, as other fluids may. 3. It is of a different denſity in every part upward from the earth's ſurface, decreaſing in its weight, bulk for bulk, the higher it riſes, and therefore muſt alſo decreaſe in denſity. 4. It is of an elaſtic or ſpringy nature, and the force of its ſpring is equal to its weight.

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* It has been found by late experiments, that water may be compreſſed, though not very much.

That air is a body is evident from its excluding all other bodies out of the ſpace it poſſeſſes; for if a glaſs jar be plunged with its mouth downward into a veſſel of water, there will but very little water get into the jar, becauſe the air, of which it is full, keeps the water out. As air is a body, it muſt needs have gravity or weight; and that it is weighty may be thus proved. Let the air be taken out of a veſſel by means of the air pump; then, having weighed the veſſel, let the air in again; and upon weighing it when re-filled with air, it will be found conſiderably heavier.—Thus a bottle, that holds a wine quart, being emptied of air and weighed, is found to be about ſixteen grains lighter than when the air is let into it again; which ſhews that a quart of air weighs ſixteen grains. But a quart of water weighs 14,621 grains; this divided by ſixteen, quotes 914 in round numbers, which ſhews that water is 914 times as heavy as air near the ſurface of the earth.*

As the air riſes above the earth's ſurface, it grows thinner or rarer, and conſequently lighter, bulk for bulk. For as it is of an elaſtic or ſpringy nature, the upper parts, being leſs preſſed than the lower, will for that reaſon expand themſelves, and occupy a larger ſpace. Dr. Cotes has proved, that if altitudes in the air be taken in arithmetical proportion, the rarity of the air will be in geometrical proportion. Thus, at the height of ſeven miles, the air is four times thinner and lighter than at the ſurface of the earth; at the height of 14 miles, it is ſixteen times thinner and lighter; at 21 miles, it is ſixty-four times; at 28 miles, it is two hundred and fifty-ſix times; at 35 miles, it is one thouſand and twenty-four times; and ſo on continually, the latter numbers increaſing in geometrical, as the former do in arithmetical proportion. And hence it is eaſy to prove, that a cubic inch of ſuch air as we breathe, would be ſo much rarefied at the altitude of 500 miles, that it would fill a hollow ſphere equal in diameter to the orbit of Saturn.

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* *Note.*—The gravity or weight of the air is continually changing: when the barometer ſtands at 30 inches, the ſpecific gravity of air is 800 times leſs than that of water, that is, one pint of water will weigh as much as 800 pints of air.

But the real weight or preſſure of the air is moſt exactly determined by what is commonly called the Torricellian experiment, which is performed in this manner:—Take a glaſs tube about three feet long, and open at one end; fill it with quickſilver, and putting your finger upon the open end, turn that end downward, and immerſe it into a ſmall veſſel of quickſilver, without letting in any air; then take away your finger, and the quickſilver will remain ſuſpended in the tube 29½ inches above the ſurface in the veſſel; ſometimes more, and at other times leſs, as the weight of the air is varied by winds and other cauſes.

That the quickſilver in the tube is kept up by the preſſure of the atmoſphere upon that in the baſon, is evident from this, that if the baſon and tube be put under a glaſs, and the air be then taken out of the glaſs, all the quickſilver in the tube will fall down into the baſon; and if the air be let in again, the quickſilver will riſe to the ſame height as before. Therefore the air's preſſure on the ſurface of the earth is equal to the weight of 29½ inches of quickſilver all over the earth's ſurface at a mean rate. A ſquare column of quickſilver 29½ inches high, and one inch thick, weighs juſt 15 pounds, which is equal to the preſſure of air upon every ſquare inch of the earth's ſurface; and 144 times as much, or 2160 pounds upon every ſquare foot; becauſe a ſquare foot contains 144 ſquare inches. At this rate, a middle-ſized man, whoſe ſurface may be about 14 ſquare feet, ſuſtains a preſſure of 30,240 pounds, when the air is of a mean gravity: a preſſure which would be inſupportable, and even fatal to us, were it not equal on every part, and counterbalanced by the ſpring of the air within us, which is diffuſed through the whole body, and re-acts with an equal force againſt the outward preſſure.

Now, ſince the earth's ſurface contains (in round numbers) 200,000,000 ſquare miles, and every ſquare mile 27,878,400 ſquare feet, there muſt be 5,575,680,000,000,000 ſquare feet on the earth's ſurface; which multiplied by 2160 pounds (the preſſure on each ſquare foot) gives 12,043,468,800,000,000,000 pounds for the preſſure or weight of the whole atmoſphere.

The ſame cauſe that makes mercury aſcend in a tube to the height of 29½ inches, is the occaſion of water aſcending in a pump to the height of 33 feet; for it will aſcend no higher: ſo that a column of water 33 feet high, is equal in weight to a column of quickſilver of the ſame diameter, 29½ inches high; and to as thick a column of air reaching from the earth's ſurface to the top of the atmoſphere.

The inſtrument, with which the Torricellian experiment is performed, being now generally uſed to determine the changes in the weight of the air, and conſequently the changes of the weather, is for that reaſon called the barometer, or weather glaſs. Sometimes the air is ſo heavy and elaſtic, as to ſupport the mercury in the tube at the height of 31 inches nearly; at other times it is ſo light and unelaſtic, as to ſuffer it to fall as low as 28 inches. The difference between theſe is three inches, that is, about $\frac{1}{9}$ of the whole weight of the atmoſphere. Our bodies, therefore, are ſometimes preſſed with a weight one ninth more, or one ninth leſs than they are at other times, that is, with about 3360 pounds more weight at one time than another. This muſt no doubt have a conſiderable effect upon our feelings, and conſequently upon our health; and the fact is, that it has ſo: but we are apt to aſcribe this effect to a wrong cauſe. When we feel ourſelves dull and languid, we think it is owing to the air's being too thick and heavy about us. But it is juſt the reverſe. The air is then too light and thin, as is evident from its wanting ſtrength to bear up the vapours that compoſe the clouds, and from the mercury's ſinking in the barometer. On the contrary, when the air is thick and heavy, the clouds mount high, the air becomes more ſtrong and elaſtic, by which means it balances the ſpring of air within us, braces up our blood-veſſels and nerves, and makes us briſk and likely.

It is impoſſible, in a ſhort ſketch of this kind, to explain all the uſes and properties of the air: I ſhall therefore content myſelf with mentioning a few more of the moſt remarkable. According to Dr. Keill, and other aſtronomical writers, it is entirely owing to the atmoſphere that the heavens appear bright in the day-time. For, without the atmoſphere, only that part of the heavens would ſhine in which the ſun was placed; and if we could live without air, and ſhould turn our backs towards the ſun, the whole heavens would appear as dark as in the night, and the ſtars would be ſeen as clear as in the nocturnal ſky. In this caſe we ſhould have no twilight; but a ſudden tranſition from the brighteſt ſunſhine to the blackeſt darkneſs immediately after ſun-ſet; and from the blackeſt darkneſs to the brighteſt ſunſhine at ſun-riſing, which would be extremely inconvenient, and highly injurious to the eyes of mortals. But, by means of the atmoſphere, we enjoy the ſun's light, refracted by the aërial particles, for ſome time before he riſes, and after he ſets. For, when the ſun has deſcended below the horizon, and conſequently is concealed from our ſight, the atmoſphere, being ſeveral miles high, has his light ſtill imparted to it, and reflects it to us. This light, or rather twilight, gradually decreaſes, till the ſun has got 18 degrees below the horizon; and then all that part of the atmoſphere which is above us is dark. From the length of the twilight it has been calculated, that the height of the atmoſphere (ſo far as it is denſe enough to reflect any light) is about 44 miles. But it is ſeldom denſe enough at two miles high to bear up the clouds. The real height, however, of the atmoſphere cannot be well aſcertained: It grows gradually rarer and rarer, the higher it aſcends; and as it is impoſſible to ſet any bounds to its rarefaction, it ſeems equally impoſſible to fix any limits to its height.

The air is rarefied, or increaſes in bulk with heat; and of this property wind is the neceſſary conſequence. For when any part of the air is heated by the ſun, or otherwiſe, it will ſwell, and thereby affect the adjacent air; and ſo, by various degrees of heat in different places, there will ariſe various winds. When the air is much heated, it will aſcend towards the upper part of the atmoſphere, and the adjacent air will ruſh in to ſupply its place; and therefore there will be a ſtream or current of air from all parts towards the place where the heat is. And hence we ſee the reaſon why the air ruſhes with ſuch force into a glaſs-houſe, or tile-kiln, or towards any place where a great fire is made; and alſo why the ſmoke is carried up a chimney, and why the air ruſhes in at the key-hole of the door, or any ſmall chink, when there is a fire in the room. So, in general, we may conclude, that the air will preſs towards that part of the world where it is moſt heated.— Upon this principle we can eaſily account for the trade winds, which conſtantly blow from eaſt to weſt between the tropics, and chiefly about the equator, For as the ſun moves from eaſt to weſt, and as the air immediately under the ſun muſt be more ſtrongly heated than that upon any other part of the earth's ſurface, it will naturally aſcend into the higher regions, and the adjacent air will as naturally ruſh in to ſupply its place; and thus a conſtant ſtream or current of air, that is of wind, will follow the ſun in his daily courſe from eaſt to weſt; only, on the north ſide of the equator, it will incline a little to the north; and on the ſouth ſide, to the ſouth.

This general courſe of the wind about the equator is changed in ſeveral places, and by a variety of cauſes. 1. By exhalations. 2. By the falling of great quantities of rain, which condenſe the air. 3. By burning ſands, which rarefy it. 4. By chains of high mountains, which break its current, and alter its direction. And 5. By the declination of the ſun towards the north ſide of the equator in ſummer, and towards the ſouth ſide of it in winter. To theſe, and other cauſes of a ſimilar nature, are owing, 1. The irregularity and uncertainty of the winds in climates at a conſiderable diſtance from the equator, as in moſt parts of Europe. Thoſe periodical winds, called monſoons, which in the Indian ſeas blow half a year one way, and the other half another. 3. Thoſe winds, which on the coaſt of Guinea, in Africa, and on that part of Peru in South America, blow almoſt always from the weſt. 4. The ſea and land breezes, which, in hot countries, blow generally from the ſea in the day time, and from the land in the night, but which do not extend above two or three leagues from the ſhore. And 5. All thoſe ſtorms, hurricanes, whirlwinds, and irregularities which happen at different times and places.

The common atmoſpheric air which we breathe conſiſts of two different kinds of air, or gases, as they are called. Theſe are denominated oxygen gas and nitrogen gas; the former is the only part that ſupports animal life and combuſtion; and in every 100 parts, whether cubical inches, or pints or gallons of common air, there are 21 of oxygen gas and 79 of nitrogen gas. The air by paſſing through the lungs in breathing ſupports animal life, that is, the 21 parts of oxygen gas are abſorbed in paſſing through the lungs, and the 79 of nitrogen are ejected as of no other uſe in the proceſs than, probably, modifying the effects of the oxygen. Hence a given portion of common air will not ſupport life longer than a certain time, viz. only till all the oxygen is abſorbed.

Fiſh die when they are excluded from freſh air, as in a pond that is cloſely frozen over. And the little eggs of inſects, if ſtopped up in a glaſs, will not produce their young, though aſſiſted by a kindly warmth; neither will the ſeeds of plants grow, though mixed with good earth, if they are incloſed in a glaſs. The oxygen or pure part of air is alſo deſtroyed by the air's paſſing through fire, particularly charcoal fire, or the flame of ſulphur; and hence it is, that ſmoky chimnies muſt be very unwholeſome, eſpecially if the rooms in which they are be ſmall and cloſe. Air is alſo corrupted by remaining cloſely pent up in any place for a conſiderable time; as in the holds of ſhips, in oil ciſterns and wine cellars, and in deep pits or wells that have been long diſuſed and covered over. In all theſe the air is ſometimes ſo much vitiated as to prove inſtant death to any animal that comes into it; becauſe in all theſe caſes the oxygen of the air is abſorbed by the carbonaceous matter, and the air becomes carbonic acid gas, in which no animal can breathe a ſingle inſtant without the riſque of immediate death.

SECT. III.

Of the TIDES.

A TIDE is that motion of the water in the ſeas and rivers, by which it is found regularly to riſe and fall. The general cauſe of this motion of the water ſeems to have been firſt diſcovered by Kepler, who, in his *Introduction to the Phyſics of the Heavens*, expreſſes himſelf thus: "The orb of the attracting power of the moon extends as far as the earth, and draws the waters under the torrid zone, acting upon thoſe places where it is vertical; inſenſibly, indeed, on confined ſeas and bays, but ſenſibly on the ocean, whoſe beds are large, and whoſe waters have the liberty of reciprocation, that is, of riſing and falling." And, in his *Lunar Aſtronomy*, he ſays, "That the cauſe of the tides of the ſea appears to be the bodies of the ſun and moon drawing the waters of the ſea." This hint being given, the immortal Sir Iſaac Newton improved it, and wrote ſo fully and ſatisfactorily on the ſubject, as to make it in a great meaſure his own, particularly by explaining the reaſon why the waters riſe on that ſide of the earth which is fartheſt from the moon, as well as on that which is neareſt to her. The ſubſtance of what he ſays on this curious topic is as follows.

The great power that actuates all matter, is gravitation. By this all bodies tend towards the centre of the earth; and the caſe is no doubt the ſame in all other ſpheres or globes. By this alſo, the ſun, the moon, and the earth, and probably too the other planets, mutually tend towards each other; but with forces, however, which gradually decreaſe as the diſtances of the bodies increaſe, and that too in proportion to the ſquare of thoſe diſtances; in other words, at double the diſtance the power of gravitation or attraction is four times leſs, at triple the diſtance it is nine times leſs, at quadruple the diſtance it is ſixteen times leſs, at five times the diſtance it is twenty-five times leſs, &c.

Now, as the earth is attracted by the ſun and moon, therefore all the parts of the earth will not gravitate towards its centre in the ſame manner as if thoſe parts were not affected by ſuch attractions. And it is evident, that, were the earth entirely free from ſuch actions of the ſun and moon, the ocean tending equally, on all ſides, towards its centre by the force of gravity, would maintain a perfectly ſpherical figure. But as the caſe is otherwiſe, the water of the ocean muſt needs riſe higher in thoſe places where the ſun and moon diminiſh its gravity, or where the ſun and moon have the greateſt attraction.

The moon, however, being by much the neareſt of theſe two luminaries, will operate with the greateſt force in producing this riſe of the waters, or the ebbing and flowing of the ſea; and its influence in this reſpect muſt be as follows: Firſt upon the hemiſphere towards the moon; where the middle point being neareſt the moon, and therefore moſt attracted by her (directly contrary to its natural gravity, or tendency to the centre) is leſs preſſed by gravitation than any other part of the ſurface of that hemiſphere, and conſequently the waters will there be the higheſt. Secondly, upon the hemiſphere that is fartheſt from the moon; where the middle point being leaſt attracted by the moon (by reaſon of its being at the greateſt diſtance from her) is left behind, while all the other parts, and even the centre itſelf, are more attracted towards her; from whence it will follow, that the ſurface of the water at the middle of that hemiſphere will be higher, or more remote from the centre, than any other part of it.

On the other hand, thoſe parts of the earth, where the moon appears in the horizon, or is 90 degrees diſtant from the zenith and nadir, will have the ebbs or loweſt waters. For, as the waters in the zenith and nadir riſe at the ſame time, the waters in the neighbourhood will ruſh in towards them, in order to maintain the equilibrium; and to ſupply the place of theſe laſt, others will move the ſame way, and ſo on gradually, till the motion reaches to 90 degrees diſtance from the ſaid zenith and nadir; conſequently in thoſe places where the moon appears in the horizon, or which are 90 degrees diſtant from the zenith and nadir, the waters will be the loweſt.

That part of the globe, therefore, which is neareſt to the moon, and that which is fartheſt from her, will naturally be the higheſt in their reſpective hemiſpheres; the former being really more elevated, and the latter leſs depreſſed, by the moon's attraction, than the adjacent parts: ſo that theſe two points may now be conceived as the ſummits of two oppoſite mountains of water, or the whole globe may be ſuppoſed to be thrown into a ſpheroidical or oval figure, whoſe longeſt diameter, if produced, would paſs through the moon, and its ſhorteſt be where ſhe is in the horizon, or at 90 degrees diſtance. And as the moon ſeems to move round the earth from eaſt to weſt, the longer diameter of the ſpheroid, following her motion, will occaſion the two tides of flood and the two tides of ebb that happen in about 25 hours; for that is the time nearly which the moon takes up in moving from the meridian of any place to the ſame meridian again.*

When the ſun and moon are in conjunction, or oppoſition, that is, at new or full moon, the attraction of both theſe bodies acting upon the earth in the ſame direction, or in the ſame right line, their force is united to elevate the waters; and conſequently then there will be ſpring-tides.—When the moon is in her quadratures, her attraction acts in one direction, and the ſun's in a quite contrary; by which means they oppoſe or counteract one another, the moon raiſing the waters where the ſun depreſſes them, and *vice verſa*; the conſequence of which is, that then there will be neap-tides.

Though the force by which the tides are raiſed is continually encreaſing from the time of the moon's quadrature to her conjunction or oppoſition, after which it gradually decreaſes till the next quadrature; yet the higheſt ſpring-tide is not juſt at the new or full moon, but a day or two after; which may be eaſily accounted for thus: conceive every tide as raiſed by a double force, viz. ſome part of the force that raiſed the laſt tide ſtill remaining, and the force of a new impulſe. When both theſe together amount to more than the whole force which raiſed the laſt tide, the preſent tide muſt riſe higher than the preceding one did. Suppoſe the remaining force to be always half the whole force of the laſt tide; ſuppoſe the new impulſe, juſt at new or full moon, to be 18, and the whole force, with which that tide is raiſed, to be 28. Let the new impulſe of the new tide be but 17; then 17 + 14 (that is, half of 28) = 31: this tide will therefore riſe higher than the laſt. Let the new impulſe of the next tide be but 16; then 16 + 15½ (that is, half of 31) = 31½: conſequently this tide will riſe ſtill higher than the laſt did, though the force of the attraction of the two luminaries, by which the tides are raiſed, is now conſiderably diminiſhed. For the ſame reaſon the deadeſt neap-tides will fall out, not preciſely at the moon's quarters, but ſome time after.

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* *Note.* The reaſon why the moon takes up about 25 hours in moving from any one meridian to the ſame meridian again, is, that though in her *daily* courſe ſhe ſeems to move round the earth from eaſt to weſt, yet ſhe really moves round it from weſt to eaſt, in the ſpace of a *month*.

If the two oppoſite protuberances or ſummits of the two mountains of water, we have mentioned above, were always exactly at the poles of the earth, there would be no riſing and falling of the waters by means of the earth's rotation round its axis, or no tides at all, becauſe at the poles the earth has no rotatory motion round its axis; and in this caſe it would conſtantly be high water at the poles, and low water at the equator. On the other hand, when theſe two ſummits are fartheſt from the poles, that is, upon the equator, the riſe and fall of the waters, by means of the earth's rotation, will be the greateſt; for the two ſummits then deſcribing a great circle of the globe in the ſame time they uſed to deſcribe a leſſer circle parallel to the equator, will conſequently move with greater rapidity, and being daſhed againſt the ſhores with greater force, will for that reaſon riſe the higher.

In general, therefore, it may be laid down as a maxim, that the nearer any place is to the equator, the riſe and fall of the waters will be the greater; and the nearer it is to the poles, the riſe and fall will be the leſs. And as the riſe of the water is owing to the joint influence of the ſun and moon, it naturally follows, that when theſe two luminaries are in conjunction or oppoſition, in or near the equinoctial, as in March and September, the ſpring-tides muſt riſe higher, (the ſummits of the two mountains being then upon the equator) than when they are in conjunction or oppoſition in the tropics, as in June and December; and, for the very ſame reaſon, the neap-tides are weaker in the two former months than they are in the latter. Yet, though the higheſt tides happen at the equinoxes, they do not fall exactly on the equinoctial days, but ſome time before the vernal, and ſome time after the autumnal equinox, viz. in February and October; the reaſon of which is, that the ſun being nearer the earth in the winter months than he is in the ſummer ones, his attractive power muſt conſequently be ſtronger in the former than it is in the latter.

It is equally certain, from what has been ſaid, that the greater the moon's meridian altitude is in any place, the greater will be thoſe tides which happen when ſhe is above the horizon; and the greater her meridian depreſſion is, the greater will be thoſe tides which happen when ſhe is below the horizon. Moreover, the ſummer day, and the winter night tides have a tendency to be the higheſt, becauſe the ſun's ſummer altitude, and his winter depreſſion, are the greateſt; but this is more particularly the caſe when the moon has north declination in ſummer, and ſouth declination in winter.

All the phenomena, hitherto explained, would exactly take place, were the whole ſurface of the earth covered with water. But as it is not, and as the natural courſe of the tides from eaſt to weſt is interrupted by large continents, and by an infinite number of iſlands, there conſequently muſt ariſe, in many places near the land, a great variety of other appearances beſide thoſe I have mentioned. Theſe appearances, therefore, will require a particular ſolution; and in this we muſt attend to the ſituation of ſhores, ſtraits, ſhoals, winds, and many other things which help to produce them.

For inſtance; as the ſea has no viſible paſſage between Europe and Africa, let them be ſuppoſed to be one continent, extending from 72 degrees north to 34 degrees ſouth latitude: the middle between theſe two would be in latitude 19 degrees north, near Cape Blanco on the weſt coaſt of Africa. But it is impoſſible that the tide ſhould flow to the weſtward upon the weſtern coaſt of Africa, becauſe the continent for above 50 degrees, both northward and ſouthward, bounds the Atlantic ocean on the eaſt, and prevents the direct paſſage of the tide either from the Indian or the Pacific ocean into it: therefore, if any regular tide, occaſioned by the motion of the ſea, from eaſt to weſt, ſhould reach Cape Blanco, it muſt come either from the north of Europe ſouthward, or from the ſouth of Africa northward, to the ſaid latitude upon the weſt coaſt of Africa. And this theory is perfectly agreeable to fact and experience; for it is well known, that the tide flows ſouthward along the weſtern coaſt of Norway, from the north cape to the Naze, or entrance of the Baltic ſea, and ſo proceeds to the ſouthward along the eaſt coaſt of Great Britain, and in its paſſage ſupplies all the harbours in thoſe parts with the tide one after another, the coaſt of Scotland having the tide firſt, as lying fartheſt to the northward. Thus, on the days of the full, or change, it is high water at Aberdeen 45 minutes after 12; but at Tinmouth Bar, the ſame day, not till three o'clock. From thence, rolling to the ſouthward, it makes high water at the Spurn a little after 5; but not till 6 at Hull, by reaſon of the time required for its paſſage up the river; from thence paſſing over the Wellbank into Yarmouth Road, it makes high water there a little after 8, but not in the pier till 9; and it requires near an hour more to make high water at Yarmouth town: in the mean time continuing its courſe to the ſouthward, it makes high water at Harwich at half paſt 10, at the Nore at 12, at Graveſend at half paſt 1, and at London at 3 o'clock. Thus it appears, that the ſame tide, which produces high water at Tinmouth Bar at 3 o'clock in the morning, does not produce high water at London till 3 in the afternoon.

While the tide, or high water, is thus gliding to the ſouthward along the eaſt coaſt of England, it alſo flows to the ſouthward along the weſt coaſts of Scotland and Ireland, and a branch of it falls into St. George's Channel, the flood running up north-eaſt, as may be naturally inferred from its being high water at Waterford above three hours before it is high water at Dublin, or thereabouts, on that coaſt; and it is three quarters of an hour ebb at Dublin before it is high water at the Iſle of Man.

But, not to draw out this article to too great a length, I ſhall content myſelf with obſerving, that the tide flows to the ſouthward from the coaſt of Ireland, and in its paſſage a branch of it falls into the Engliſh Channel, between the Lizard and Uſhant; this progreſs of the tide to the ſouthward may eaſily be proved by its being high water on the day of the full and changes at Cape Clear a little after 4 o'clock, and at Uſhant about 6, and at the Lizard after 7. The Lizard and Uſhant may properly be called the chaps of the Engliſh Channel, between which the tide flows to the eaſtward along the coaſts of England and France, till it comes to the Goodwin or Galloper, where it meets the tide above mentioned, which flows to the ſouthward along the eaſtern coaſt of England; and the meeting of theſe two tides contributes very much towards ſending a powerful tide up the river Thames to London. And when the natural courſe of theſe two tides has been interrupted by a ſudden change of the wind, by which means that tide was accelerated which had before been retarded, and that driven back which was before hurried in by the wind, it has been known to occaſion high water twice in three or four hours, which by thoſe who did not underſtand this natural cauſe, has been looked upon as a prodigy.

If it ſhould be ſaid, that this courſe of the tides eaſt, or eaſt-north-eaſt, up the Channel, is inconſiſtent with the theory which ſuppoſes them to move from eaſt to weſt, the anſwer is obvious. Though in the main ocean, where the tides meet with no obſtruction, they regularly follow the influence of the ſun and moon in moving from eaſt to weſt, yet in rivers, channels, and even in narrow ſeas, they ſometimes move towards the north, the ſouth, or even towards the eaſt, according as the waters in the neighbourhood are higher or lower.

This will be eaſily underſtood by any one who is ſufficiently acquainted with hydroſtatics to know that water, if not counteracted by ſome ſuperior power, always endeavours to come to a level.

There are no tides in lakes, becauſe they are generally ſo ſmall, that when the moon is vertical ſhe attracts every part of them alike, and as all the water is thus rendered equally light, no part of it can riſe higher than another. To the ſame cauſe it is ſuppoſed to be owing, that the Mediterranean and Baltic ſeas have no tides, at leaſt no very perceptible ones; though a different reaſon is ſometimes aſſigned for this phenomenon, and that is, that the inlets, by which theſe ſeas communicate with the ocean, are ſo ſmall, as not to be capable, in the ſpace of a few hours, to receive or diſcharge a ſufficient quantity of water to raiſe or ſink their ſurfaces conſiderably. The time of high water, in any place, happens about the ſame hour after a period of 15 days nearly, which is the interval between one ſpring-tide and another; and during that period the time of high water happens every day later by about 48 minutes.

We ſhall conclude this account of the tides with a few words concerning the ſaltneſs and depth of the ſea. Dr. Halley has aſſigned the moſt probable cauſe of its ſaltneſs. He ſays, that all the lakes in the world, properly ſo called, are found to be ſalt; ſome more, ſome leſs than the ocean, which in the preſent caſe may alſo be conſidered as a lake; ſince by that term is meant nothing more than ſuch ſtanding waters as perpetually receive rivers running into them, and have no exit or evacuation, but what is exhaled by heat. And having given us a liſt of the moſt remarkable lakes, he ſuppoſes, that as all thoſe lakes receive rivers, and none of them have any diſcharge but by exhalation, ſo it will be neceſſary, that their waters riſe till ſuch time as their ſurfaces are ſufficiently extended to make them exhale in vapour as much water as is poured in by the rivers. But the vapours thus exhaled are perfectly freſh; ſo that the ſaline particles, that are brought in by the rivers, remain behind, while the freſh ones only evaporate; and hence it is evident, that the ſalt in the lakes will be continually augmented, and the water grow ſalter and ſalter. But in lakes where the water runs off as faſt as the freſh water rivers pour in, the ſaline particles can never be accumulated to to any conſiderable degree. Now if this be the true cauſe of the ſaltneſs of lakes, it is not improbable that it may likewiſe be the reaſon of the ſaltneſs of the ſea.

That exhalations from ſea water are perfectly freſh, is proved by a variety of experiments; conſequently all rain, hail, and ſnow is freſh, and ſo muſt the rivers be that originate from or are ſupplied by them. Rain water, juſt fallen, is ſuppoſed to be the pureſt and lighteſt of all waters with regard to earthy particles; and as it is reckoned to be of the ſame kind wherever it falls, philoſophers have choſen it to be the meaſure, with which the weight of all other bodies is beſt compared.* After all, there is no water perfectly pure; for even this rain water abounds with the eggs of many very ſmall animals, which, floating in the atmoſphere, are brought by the rain to the earth. The water of ſprings and rivers is generally impregnated with the particles of earths, ſalts, ſulphurs, minerals, &c. which the water is ſtrained through, or runs over; and is, for that reaſon, ſomewhat heavier than rain water, though not ſo heavy as ſea water, on account of the quantity of ſalt with which the latter is impregnated,

The depth of water in the ſea is various. In many places its bottom may be found by a piece of lead tied to the end of a long line, and even the nature of its bottom aſcertained by filling the lower end of the lead with tallow, by which means it will bring up, ſticking to it, ſome of the looſe particles from the bottom of the ſea, and thereby ſhew the nature of that bottom, whether is be ſand, gravel, ſhells, mud, &c. And though in many places no bottom can be fonnd by ſounding, or letting down the lead, it muſt not thence be inferred that the ſea has no bottom. It has been conjectured, with great probability, that the depths of the ſea, and the heights of the land above the ſurface of the ſea, are not very different. Now it is well known, that there is no land, or ſummit of a mountain, more than three or four miles in perpendicular height above the level of the ſea; therefore it may be ſuppoſed, that the ſea is not much more than three or four miles deep in any part; and could an exact repreſentation be given of the depths of the ſea in different places, it would probably appear, that it has much the ſame irregularity in its bottom, as the land has in its ſurface.

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* It is aſcertained the pure water in all parts of the world is of the ſame weight, viz. the cubic foot weighs 1000 ounces avoirdupoiſe.

SECT. IV.

A SHORT SYSTEM OF CHRONOLOGY.

CHRONOLOGY, or the doctrine of time, is intimately connected with the uſe of the globes, inaſmuch as many of the problems require a perſon to be thoroughly acquainted with the nature of years, months, and days; and alſo as both the Julian and Gregorian calendars, or (as they are commonly called) the Old and New Stile, are inſcribed upon the horizons of many globes, and therefore ought to be explained in all books that treat of their uſe.

Time is divided into hours, days, weeks, months, and years. Days are either natural or artificial. A natural day is the time that paſſes while the ſun goes from any meridian till he returns to it again; or, to ſpeak more properly, while the earth revolves about its axis. An artificial day is the time between the ſun's riſing and ſetting; to which is oppoſed the night, that is, the time the ſun is hidden under the horizon. The natural day is divided into 24 hours, each hour into 60 minutes, each minute into 60 ſeconds, each ſecond into 60 thirds, &c. The artificial days are always unequal to all the inhabitants that are not under the equator, except when the ſun is in the equinoctial points ♈ and ♎, which happens about the 21ſt of March, and the 22d of September; at thoſe times the ſun riſes and ſets at ſix, to all the inhabitants of the earth.

All nations do not begin their day and reckon their hours alike. In Great Britain, France, and Spain, and in moſt other countries in Europe, the day is reckoned to begin at midnight, from whence is counted 12 hours till noon, then 12 hours more till next midnight, which makes a natural day. Yet, even in thoſe countries, the aſtronomers commonly begin their day at noon, and ſo reckon 24 hours till next noon, and not twice 12, according to the vulgar computation. The Babylonians began their day at ſun-riſing, and reckoned 24 hours till he roſe again. This way of computation we call the Babyloniſh hours. In ſeveral parts of Germany, they count their hours from ſun-ſetting, calling the firſt hour after the ſun has ſet, the firſt hour, &c. till he ſets the next day, which they call the 24th hour. Theſe are commonly called the Italian hours. According to both theſe ways of computation, their hours are either a little greater or leſs than the $\frac{1}{24}$ part of a natural day, in proportion as the ſun riſes or ſets ſooner or later in the ſucceeding days. They have alſo this inconvenience, that their mid-day and midnight happen on different hours, according to the ſeaſons of the year. The Jews and Romans formerly divided the artificial days and nights, each into 12 equal parts: theſe are termed the Jewiſh hours, and are of different lengths, according to the ſeaſons of the year; a Jewiſh day-hour in ſummer being longer than one in winter, and night-hour ſhorter. This method of computing time is now in uſe among the Turks, and the hours are ſtiled the firſt, ſecond, third, &c. hour of the day or night; ſo that mid-day always falls on the ſixth hour of the day.

There is nothing in nature that ſuggeſts the idea of dividing time into weeks; ſo that a week ſeems to be merely a civil, or rather a religious inſtitution, as among all nations, that have any notion of religion, one day in ſeven is ſet apart for public worſhip. For this purpoſe Chriſtians obſerve Sunday, or the firſt day of the week; the Jews obſerved Saturday, or the ſeventh day of the week; and the Turks perform their religious ceremonies on Friday.

A month is properly that ſpace of time which is meaſured by the moon in her courſe round the earth. A lunar month is either periodical or ſynodical. A periodical month is the time which the moon takes up in performing her courſe from one point in the ecliptic till ſhe returns to it again, which is 27 days, 7 hours, 43 minutes, 4″ 45‴; and a ſynodical month, or (as it is ſometimes called) a lunation, is the time betwixt one new moon and the next new moon, which is 29 days, 12 hours, 44′ 2″ 53‴. Therefore, though in the ſpace of a year the moon performs 13 revolutions round the earth, or completes 13 periodical months, and ten days over, yet there are but twelve lunations, or ſynodical months, and eleven days over, in a year. There is a third kind of month, different from both the former: it is called the civil month, and conſiſts of a certain number of days, either more or fewer, according to the laws and cuſtoms of the country where ſuch months are obſerved.

The completeſt period of time is a year, in which all the ſeaſons return in ſucceſſion, and begin anew. A year is either aſtronomical or civil. An aſtronomical year again is either ſiderial or tropical. The ſiderial year is the ſpace of time that paſſes while the ſun goes from any fixed ſtar to the ſame again. It conſiſts of 365 days, 6 hours, 9′ 14″. The tropical year is the ſpace of time that paſſes while the ſun goes from either tropic, or from any point of the ecliptic, to the ſame again. This is ſomewhat ſhort of the ſiderial year, becauſe every point of the ecliptic goes backwards about 50 ſeconds of a degree in a year (owing to what is uſually called the preceſſion of the equinoxes), thereby meeting the ſun, as it were, which makes the ſun return to the ſame point of the ecliptic, about 20 minutes of time before he arrives at the ſame fixed ſtar from which he ſet out the preceding year. The tropical year, therefore, is ſhorter than the ſiderial year, and conſiſts of 365 days, 5 hours, 48′ 57″. The civil year is the ſame with the political, and is that which is eſtabliſhed by the laws of any particular country.

Days, months, and years, however, were all of them originally very imperfect, as reſulting from very groſs obſervations; and indeed aſtronomy, in its infant ſtate, afforded no better means of computation. Nay, the year, as inſtituted by Romulus, the founder of Rome, conſiſted but of ten months, beginning with the month of March; but as this was ſhort of the ſun's period by two months, theſe were afterwards added by his ſucceſſor, Numa Pompilius, and were called January and February. By theſe means the Roman year conſiſted of 12 months. But the months of this year being lunations, or lunar ſynodical months, of 29½ days each, this civil lunar year conſiſted but of 354 days; but as the ſun, in revolving once through the ecliptic, was found, in proceſs of time, to take up 365 days, or 11 days more than the lunar year; theſe were added to it by the emperor Julius Cæſar, and on that account it was called the Julian year. The 11 days added, to render the lunar equal to the ſolar year, the Greeks called Epagomenœ, and hence their modern name *epacts*.

But the year thus conſtituted by Julius Cæſar, of 365 days, was obſerved by the aſtronomers of that age to be about ſix hours ſhorter than the time the ſun took up in running through the ecliptic. The emperor, therefore, ordered, that every fourth year ſhould conſiſt of 366 days, in order that the ſeaſons of the year might be always fixed to the ſame parts of the calendar, and the feaſts and faſts be thereby rendered certain and invariable. This he did as Pontifex Maximus, or High Prieſt in the Roman hierarchy. This odd day was in every fourth year added to the 24th of February. And, according to the Roman way of reckoning, was the *Dies ſextus ante kalendas Martii*, or the ſixth day before the firſt of March; ſo that there being then *bis ſextus dies*, or two ſixth days, gave occaſion for that year to be called *Annus Biſſextilis*, or Biſſextile year, which we now commonly call Leap-year.

In order to know whether any particular year be Leap-year or not, divide it by 4, and the remainder, if there be any, ſhews how many years it is ſince Leap-year; and, if there be none, then it is Leap-year. Or you may omit the hundreds and thouſands, and divide only the units and tens by 4, and the reſult will be the ſame. Example, for the preſent year: Divide 1809 by 4, the remainder is 1; or divide only 9 by 4, the remainder is likewise 1; conſequently 1809 is not Leap-year. Divide 1812 by 4, the remainder is 0; or divide only 12 by 4, the remainder is likewiſe 0; conſequently 1812 is Leap-year.

Six hours, however, were afterwards found to be too much by 11 minutes 3 ſeconds, for ſo much does the ſolar or tropical year want of 365 days 6 hours. By the addition, therefore, of ſix whole hours, the ſun each year began his courſe, or entered the firſt ſign of the ecliptic 11′ 3″ before the preceding year was ended. This preceſſion of the ſun, as it may be called, or as it is uſually termed, of the equinoxes, amounts to one whole day in 131 years. From Julius Cæſar to the Council of Nice, A. D. 325, was about 372 years. At that time the vernal equinox fell upon the 21ſt of March, and conſequently every 131 years after, the equinox muſt anticipate one whole day; therefore the ſeaſons of the year, and feſtivals of the church, muſt be rendered moveable, and in time go retrograde through the whole calendar. This ſoon alarmed the fathers of the primitive church, whoſe knowledge, or rather whoſe ignorance of aſtronomy never ſuffered them to ſuſpect any ſuch thing: and as Eaſter (the principal feaſt) had been fixed to the Sunday, which was the firſt after the new moon that happened next after the 21ſt of March, or vernal equinox, they ſaw with concern the unſtable condition of their rubric; and in the time of Pope Gregory XIII. this grievance had grown to ſo great a height, that the ſaid equinox, and Eaſter of courſe, had anticipated the time to which the fathers of the Nicene Council ſuppoſed they had fixed it, no leſs than 10 days.

This Pope, therefore, convened a council of the beſt aſtronomers of that age, and after a minute examination of the matter, it was ordained, that ten days ſhould be taken from the month of October in 1582, by reckoning the 5th day as the 15th. And to prevent the regreſs of the equinoxes for the future, and conſequently any irregularity in the calendar, it was further ordained, that every hundredth year, which in the Julian account was a Leap-year, ſhould in this be only a common year, and conſiſt of but 365 days; but as that was too much, every four hundredth year was to remain a Leap-year or Biſſextile. This reformation of the calendar is called the Gregorian account, or New Stile; and according to this ſtile was the calendar rectified in England in 1752, by throwing out 11 days in the month of September, as from the Council of Nice to that year 1427 years had elapſed; and, beſides, the beginning of the civil year was fixed to the firſt day of January

EXERCISES

ON THE

MAP OF THE WORLD.

HOW is Aſia ſeparated from North America?

Which is the more northerly, Baffin's-Bay or Hudſon's Bay?

Through what degree of latitude does the northern part of Newfoundland paſs?

Does Terra Del Fuego join the continent of South America?

Which is the moſt eaſterly cape of South America?

How do Cuba, Domingo, and Jamaica lie with reſpect to each other?

How are the Caribbee Iſlands ſituated?

What ſtrait is that which leads to Baffin's Bay?

The Azores and Cape Verd Iſlands have nearly the ſame longitude, what are their latitudes?

Of what does New Zealand conſiſt?

What are the two Capes of New Zealand called?

How is Patagonia ſituated?

On what degree of latitude are the Bermudas?

Weſt of what gulf are the Bahama iſlands?

In what part of North America are the Foxes iſlands?

Near what conſiderable line are the Sandwich iſlands ſituated?

How are the New Hebrides, the Navigators, and the Society's iſlands ſituated?

What is the latitude of Cape Farewell in Greenland?

Near what circle of latitude are the Marqueſas and Charlotte iſland?

Through what iſland does the 20th degree of ſouth latitude paſs?

How are Peru and Chili ſituated?

What circle of longitude paſſes through the Falkland iſlands?

It is now five o'clock in the morning at London, what time is it at the Falkland iſlands?

There are Sandwich iſlands in the Southern as well as the Northern hemiſphere, in what latitude are they?

How is New Grenada ſituated?

In what part of North America is California?

What is the northern boundary of the United States?

The neck of land that joins North and South America is called the iſthmus of Panama, in what latitude is it?

How is Mexico ſituated?

Which part of South America is denominated Brazil?

Which part of North America is called Labrador?

How is Paraguay ſituated?

What is the difference of time between the moſt Weſtern and moſt Eaſtern parts of South America?

When it is nine in the morning at the Galapagos, what o'clock is it at Behring's Straits?

What is that part of the Indian ocean called that lies between Madagaſcar and Africa?

Through what large iſlands does the equator paſs?

Near what circle of longitude are the Ladrones?

What ſtrait ſeparates New Holland from Dieman's land?

What is the latitude of Deſolation iſland?

By what is Africa ſeparated from Aſia?

How is the Caſpian Sea ſituated with regard to the Black Sea?

How is the iſland of Formoſa ſituated?

What is the latitude of the Cape of Good Hope?

Oppoſite to what part of the continent is England?

Is New Guinea or New Georgia the moſt weſterly?

What is the latitude of the moſt ſoutherly part of New Holland?

In what ſituation is the iſland of Ceylon?

What is that gulf that ſeparates Perſia from Arabia?

Where is the ſea of Okotſh?

Between what parallels of latitude is Japan?

Are the Maldivas North or South of the equator?

Which is the moſt ſouth, Cape Horn or the Cape of Good Hope?

Are the Philippine iſlands, or the New Philippines, neareſt to the equator?

What is the latitude of the moſt ſoutherly part of Hindoſtan?

What are thoſe ſtraits that ſeparate New Holland from New Guinea?

Near what parallel of ſouth latitude are the Sunda iſlands?

Is Pekin or Canton the moſt northerly city?

When it is noon at London, what o'clock is it at the moſt ſoutherly part of New Holland?

What is the difference of time between the moſt eaſterly part of Iceland, and the moſt weſterly part of New Georgia?

When it is eight in the morning at Behring's ſtrait, what is the time on the eaſtern extremity of Mindanao?

Exercises on the Map of Europe.

NEAR what gulf ſtands the city of Peterſburg?

What large town ſtands on the river Dwina, near the White Sea?

On what degree of longitude is Cape St. Vincent?

What is the capital of Italy?

How is Corinth ſituate?

What large town ſtands on the weſtern point of the Caſpian Sea?

Is the iſland of Sicily or Malta the moſt ſoutherly?

How is Africa ſeparated from Europe?

At what part do theſe continents approach the neareſt?

Is Warſaw or Cracow the moſt northerly town?

What range of mountains ſeparate Poland from Hungary?

How is Abo ſituated?

What two principal rivers in France flow into the Bay of Biſcay?

Paris ſtands on the river Seine, into what ſea does that river flow?

What is the courſe of the Rhone?

Ivica, Minorca, and Majorca were anciently called the Baleares, how are they ſituated with regard to each other?

What large river flows into the Caſpian ſea?

What are the longitude and latitude of Moſcow?

Dantzick is a ſea port, how is it ſituated?

Which is that part of Norway called the Naze?

What are thoſe mountains called that ſeparate Italy from France and Switzerland?

How are the iſlands of Candia and Rhodes ſituated with regard to one another?

Is Corſica or Sardinia the moſt northerly?

Port Mahon gives a title to a young nobleman, where is it ſituate?

What is the capital of Corſica?

Hamburgh is a celebrated commercial town in Germany, on what river does it ſtand?

What town is ſituate at the northermoſt part of the gulf of Bothnia?

Is lake Ladoga or Onega the moſt eaſterly?

How is Liſbon ſituate?

How are Venice, Genoa, and Turin ſituate with reſpect to each other?

Point out the capital of each country in Europe, namely, Stockholm, Copenhagen, Chriſtiana, Peterſburg, Amſterdam, Paris, Vienna, Warſaw, Madrid, Liſbon, Rome, and Conſtantinople.

On what river in France is Bourdeaux?

What range of mountains ſeparate Norway from Sweden?

How is Iceland ſituate?

On what river does Rome ſtand?

To what ſeas does the Archipelago lead?

Pindus and Athos are celebrated mountains in Greece, can you point them out in the map?

Corinth and Athens are celebrated in ancient hiſtory, can you ſhew their poſition?

Find me the following towns, which are ſituate in Germany, Hanover, Frankfort, Ratiſbon, Munich, Prague, Straſburg, and Saltſburg.

Tyro. If you have now finiſhed your queſtions, permit me to aſk one or two. At the bottom of the map it is ſaid 40 minutes after London, and 2 hours before London, what does this mean?

Philo. The people who live all the way up that line which have the figures 40 at bottom, and 10 at top, have their time 40 minutes later than the people of London. That is, to the people at Cape St. Vincent, Cape Finiſterre, and the weſtern part of Ireland, it wants 40 minutes of noon when it is noon at London. But when it is noon at London, it is one o'clock at Malta, ſome parts of Sicily, Italy, Germany, Sweden, &c.: and ſtill farther *eaſt*, as at Wardhuys, Peterſburg, &c. it is two o'clock.

Tyro. Do the figures at the top of the map mark the degrees of *longitude*, and thoſe at the bottom the *time*?

Philo. They do: and according to a former Problem each 15° of longitude are equal to an hour in time; conſequently, to all the people 15° weſt of London, the hour of the day is an hour later; to thoſe 15° eaſt, it is an hour ſooner.

Thus the people of Moſcow live 40° eaſt of London; conſequently they are two hours and 40 minutes ſooner in their reckoning of time; or when it is twelve o'clock in London, it will want but twenty minutes to three in the afternoon to the inhabitants of Moſcow.

Exercises on the Map of the British Isles.

HOW is England ſeparated from the continent?

Oppoſite to what Engliſh county is the Hague?

How is the Iſle of Wight ſituate?

If I ſail up the Thames to Scotland, by what Engliſh counties muſt I paſs?

Is Holy Iſland North or South of the Tweed?

If I ſail from London to Briſtol, what counties in England ſhall I paſs?

What large river empties itſelf into the Britiſh Channel?

How is the iſland of Angleſea ſituate?

Colerain in Ireland is famous for its linen where does it ſtand?

Ireland is divided into four provinces, what ar their names, and how are they ſituate?

The French landed ſome troops laſt war Bantry Bay, which was the neareſt conſiderable city to that place?

Where is Cape Clear in Ireland?

St. Kilda, one of the Weſtern iſlands, is famous for eagles, on what degree of longitude does it lie?

What part of the United Kingdom is oppoſite to Stavanger, the moſt weſterly part of Norway?

How is the iſle of Sky ſituate?

There are four of the Weſtern iſlands lie in a line North and South, what are their names?

Where is the Iſle of Man?

Is Newcaſtle or Durham the moſt northerly?

What degree of latitude runs through the Scilly iſlands?

Where is Milford Haven?

Flamborough Head is at the diſtance of a few miles from a famous watering place in the north, what is its name?

How many degrees weſt of London is the Land's End?

What are the longitude and latitude of Start Point?

Is Belfaſt or Antrim the moſt northerly town?

What is the latitude of the Lizard Point?

Tyro. On this map is a ſcale of miles, what is the uſe of it?

Philo. Suppoſe you want to know the diſtance between any two places, as London and Bath, open your compaſſes, ſo as to touch both places, and then carry them to the ſcale, and you will find the diſtance nearly.

Tyro. Why not accurately?

Philo. Becauſe there are ſcarcely any roads that do not wind; but the meaſure taken by the compaſſes is the direct, and of courſe the ſhorteſt line from place to place; therefore the diſtance on the ſcale will always be leſs than the real diſtance.

Tyro. What is the meaning of the figure in the left hand bottom corner of the map?

Philo. It is, or ought to be, on all maps, in order to ſhew the *cardinal* points, or the north, ſouth, weſt, and eaſt points of the map.

Tell me the diſtance between London and Ipſwich, and between Dublin and Cork?

Are the clocks at the Hague before thoſe of London?

What is the difference in time between London and Port-Patrick in Scotland?

Exerciſes on the Map of Asia.

WHAT is the name of the ſtrait that leads into the Red Sea?

What conſiderable river runs into the Perſian Gulf?

Into what ſea does the Ganges empty itſelf?

What is the name of the ſtrait that ſeparates Malacca from Sumatra?

What is the capital of the iſland of Java?

What is the name of the eaſtern coaſt of the peninſula of India?

The iſland of Socotra is famous for its aloes; how is it ſituate?

Is Mecca or Medina the moſt northerly town?

What is the moſt ſoutherly cape of India called?

On which coaſt of India is Bombay?

Is Viſiapour or Golconda the moſt northerly?

Laſſa is the capital of Tibet, what is its latitude?

How is the ſea of Corea ſituate?

Point out the place where Troy was ſuppoſed to ſtand?

Through what iſlands does the equator paſs?

Where is Nova Zembla?

Which are the more eaſterly, the Philippines or the Ladrones?

On which coaſt of India are Pondicherry and Fort St. George?

How is Pekin ſituated with reſpect to the Great Wall?

What is it that renders Arabia a peninſula?

Where ſhall I find the iſland of Ceylon?

What countries does the Bay of Siam waſh?

The tropic of Cancer croſſes the iſland of Formoſa, what o'clock is it there when it is ten at night in London?

Iſpahan is the capital of Perſia, how does that city ſtand with regard to mount Taurus?

Near Lahor in the Mogul's territory, a ſhower of ſtones was ſaid to have fallen from the clouds in the year 1798, what is the latitude of that place?*

How is the iſland of Japan ſituated?

How are Ava, Pegu, Siam, Cambodia, Cochin China, and Tonquin ſituate?

Lake Baikal, in Siberia, is of conſiderable ſize; between what meridians is it ſituate?

Exerciſes on the Map of AFRICA.

Which are the northern ſtates of Africa?

On what river does Cairo ſtand?

How do Tripoli, Tunis, and Barca ſtand with reſpect to one another?

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* See Philoſoph. Tranſactions for 1799.

What is that range of mountains called which ſeparate the northern ſtates from Biledulgerid?

How is the iſland of Madeira ſituate?

What cape is that ſouth eaſt of the Canary iſlands?

Through what Deſert does the tropic of Cancer run?

Are the Cataracts on the Nile north or ſouth of the tropic of Cancer?

Near what Cape does the river Gambia empty itſelf?

What is the latitude of Sierra de Leone?

Between what parallels of latitudes do the Cape de Verd iſlands lie?

What are the longitude and latitude of the iſland of Goree?

How is the coaſt of Guinea divided?

What is the channel called that ſeparates Madagaſcar from the continent of Africa?

Point out the ſource of the Nile.

How are Aſcenſion, St. Matthew, and St. Helena iſlands ſituate?

Is Congo or Loango the moſt northerly?

What is the latitude of Anaboa iſland?

Into what part of the ocean does the river Cuama flow?

What is the weſtern coaſt of the Red Sea called?

What is the moſt eaſterly cape of Africa named?

What conſiderable iſland is nearly oppoſite to this cape?

Is Angola or Benguela the moſt northerly ſtate?

What range of mountains ſeparates Monomugi from Zanguebar?

What part of Africa is denominated Caffraria?

What is the moſt ſoutherly cape of Africa?

Lake Zachaf is ſituated eaſt of the mountains that ſeparate Benguela from Monomugi; with what two rivers is it connected?

How is Terra de Natal bounded?

Oppoſite to what large iſland is Sofala ſituate?

Near what great line are the Almirante Iſlands?

Are the Pyramids of Egypt eaſt or weſt of the Nile?

Africa is ſeparated from Aſia by a neck of land, or iſthmus, which takes its name from a town at the north point of the Red Sea; what is that iſthmus called?

When it is eight o'clock in the morning at London, what is the time at Capes Guardafia, Moſambique, and Verd?

Are the clocks at Algiers before or behind thoſe of Tripoli?

Which part of Africa is denominated Ethiopia?

What is that part of Africa called which lies eaſt of Ethiopia?

Exercises on the Map of NORTH AMERICA.

WITH what great river are the lakes of North America connected?

What is the name of that ſmall iſland ſituated at the mouth of the river St. Laurence?

Newfoundland is famous for its cod-fiſhery, how is it ſituated?

How is Labrador ſituated?

What is that bay called which is ſouth of Hudſon's Bay?

Near to which of the United States is Long Iſland?

Which is the largeſt of the lakes in North America?

How is Fundy Bay ſituated?

The American war commenced at Boſton, how is that town ſituated?

How is Cape Breton ſituated, and what is its capital town?

In what gulf is St. John's ſituated?

Point out Quebec and Montreal, the two principal towns of Canada.

Is Virginia or Carolina the moſt northerly ſtate?

Into what gulf does the Miſſiſſippi flow?

Of what river are the Miſſouri and Ohio Rivers branches?

Trace the courſe of the Lakes and river St. Lawrence into the ocean.

What is the latitude of Cape Florida?

Into which of the States does the Cheaſapeak Bay run?

To what does the gulf of Florida lead?

What other name is given to Mexico?

What is the capital of Cuba?

Is Jamaica or St. Domingo the moſt weſterly iſland?

Providence is the largeſt of a cluſter of iſlands, what is the name of that cluſter?

What are the latitude and longitude of Porto Rico?

What coaſt does the bay of Campeachy waſh?

How is Porto Bello ſituated?

Near what great river is Trinidad ſituated?

Enumerate the principal of the Caribbee iſlands.

What are the longitude and latitude of Acapulco?

Savanna is the capital of Georgia, how is it ſituate?

What is the longitude of Cape Cod?

When it is twelve o'clock at London, what o'clock is it at the weſtern part of Cape Breton?

How much behind the clocks of Barbadoes are thoſe of Mexico?

What is the longitude of the eaſtern part of the iſland Anticoſti?

What is that range of mountains called which ſeparates the United States from Louiſiana?

What is the moſt ſoutherly cape of New Scotland?

Exercises on the Map of SOUTH AMERICA.

WHAT is the northern part of South America called?

What large river is that which empties itſelf into the Atlantic near the equator?

What is the moſt ſoutherly cape called?

What is that ſtrait which ſeparates Terra Del Fuego from the continent?

What are the longitude and latitude of the Falkland iſlands?

What is that range of mountains called which runs almoſt the whole length of South America?

Is Chili or Peru the moſt northerly diſtrict?

How is Guiana ſituated?

What cluſter of iſlands are thoſe through which the equinoctial and the meridian of 90° Weſt paſs?

What large town is that which is ſituated on the banks of Buenos Ayres?

Potoſi is celebrated for its ſilver mines, what is it's latitude?

How is Quito ſituated?

What is the latitude of Lima?

On what part of the coaſt are the iſlands of Chiloe and Juan de Ferdinandos?

Paraguay was famous for the reſidence of the Jeſuits, how is it ſituated?

The two moſt eaſterly capes are St. Roque and St. Auguſtin, how are they ſituated?

There are two iſlands in this map named Trinidad, how are they ſituated?

Exerciſes on the Maps of SOUTH *and* NORTH AMERICA.

POINT out Cat Iſland among the Bahamas; this was the firſt place at which Columbus landed; by the natives it was called Guanahani, and by the Spaniards St. Salvador.

Which courſe muſt Columbus have ſteered to reach Cuba?

From Cuba he ſteered to Domingo, what courſe did he take?

In his ſecond voyage Columbus viſited Antigua, Guadaloupe, and Porto Rico; ſhew me their ſituation. On one of his expeditions from St. Domingo, he diſcovered Jamaica, how is that iſland ſituate?

In leaving the iſland of Trinidad, he became entangled with the current of Oronoque, from which he concluded he had reached the continent; how is that iſland and the river ſituated with reſpect to each other?

In his third voyage he explored the bay and coaſt of Honduras, as far as Porto Bello, where he wiſhed to plant a colony; trace his courſe in the map.

One of the firſt ſettlements in South America was at St. Martha, how is that ſituated?

What are the longitude and latitude of Acapulco?

Cortes diſcovered California, how is that ſituated?

How far diſtant is Cuſco from Lima?

In what part of New Spain is Guatimala?

When Pizarro ſet out on the conqueſt of Peru, he ſailed from Panama; how is that place ſituated?

He was two years in ſailing to Guaquil, how many degrees of latitude did he paſs over?

The Spaniards deſtroyed 4000 Peruvians at Caxamalca, how is that town ſituated?

They ſoon after made themſelves maſters of Cuſco, on what meridian does that ſtand?

What is the latitude of Carthagena, one of the principal towns of Terra Firma?

FINIS.

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Preceſsion of the Equinoxes is advancing or going forward of the Equinoctial point,

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Moon's evection is an inequality in the motion of the Moon

Inherent Motion of a Planet

the meaning of inherent is sticking fast in, cleaving, abiding in.